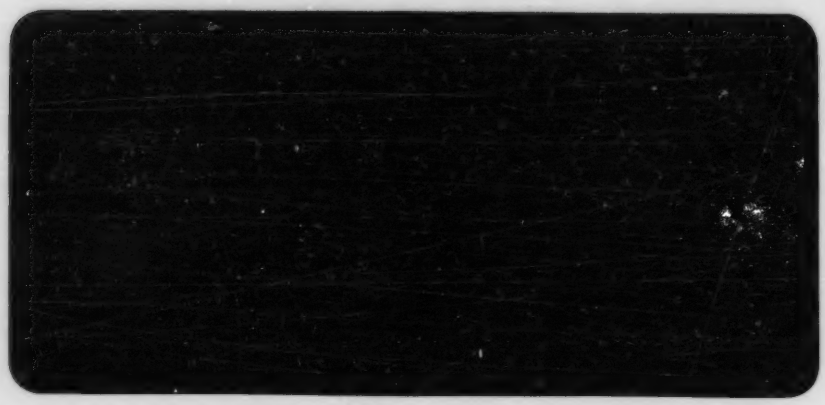
# Working Paper



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# The Canadian Economic and Fiscal Model
# 1996 Version

# CEFM96

## CEFM96 : Part 1

## MODEL STRUCTURE

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## ABSTRACT

The first version of the Canadian Economic and Fiscal Model (CEFM) was completed in 1986. Since then, CEFM has been used by the Department of Finance for macroeconomic forecasting and policy analysis. The model has gone through many rounds of revision since its original version. This report documents the theoretical structure of the 1996 version of the model, CEFM96. Companion papers contain up-to-date descriptions of the empirical specification, the forecast performance, and dynamic simulation properties of this version of the model.

The design of the model is constrained by the fact that it must serve two purposes: forecasting and policy analysis. This is not a trivial constraint: it is well known that a trade-off often exists between having a model that performs well in a forecast mode and having one with theoretically desirable simulation properties. In addition, one main objective of the forecasting process in the Department of Finance is to predict at a fairly detailed level the outlook for federal government revenues and expenditures. As a result, CEFM96 has quite a detailed government sector. Despite these constraints, however, the 1996 version of CEFM has properties that closely approximate those of a tight theoretical model.

We adopted a strategy in which we treated the determination of the equilibrium long-run value for key economic variables separately from the dynamic adjustment or determination in the short run. As a result, we modelled key choice decision variables within an error-correction structure, since such a framework appears ideally suited for that purpose. This framework allows the testing and/or imposition of long-run relationships between economic variables, often suggested by economic theory, without imposing such relationships on short-term dynamics.

Building a model that embodies sound economic theory and appropriate econometric foundations would not have been possible without reducing the size of the core model. We thus reduced the size of the model significantly in many sectors, while choosing a top-down approach in other sectors. This means a simpler, more transparent model with properties that can be more easily interpreted in relation to its theoretical specification. Overall, this approach improves the theoretical consistency of the model as well as its ability to forecast.

## RÉSUMÉ

La première version du Modèle économique et fiscal canadien (MEFC) a été complétée en 1986. Depuis lors, le MEFC a été utilisé par le Ministère des Finances à des fins de prévisions macro-économiques et d'analyse de politiques. La version originale du MEFC a été révisée à maintes reprises. Ce rapport documente la structure théorique de la version la plus récente du modèle, la version MEFC 96. Une description à jour de la spécification empirique, de la capacité à prévoir et des propriétés en simulation dynamique de cette version du modèle, se retrouve dans deux autres documents.

La structure du modèle est contrainte par le fait qu'il doit remplir un double emploi : la prévision et l'analyse de politiques. Ceci n'est pas une contrainte mineure puisqu'il est bien connu qu'il existe souvent un dilemme entre avoir un modèle qui se comporte bien en mode de prévision et un modèle qui possède les propriétés théoriques souhaitées en simulation dynamique. De plus, un des principaux objectifs du processus de prévision au Ministère des Finances est de prévoir à un niveau détaillé les perspectives de revenus et de dépenses du gouvernement fédéral. Par conséquent, la version MEFC 96 a un secteur gouvernemental assez détaillé. Ces contraintes rendent plus difficile le développement d'un modèle purement théorique.

Nous avons adopté une approche où la détermination de l'équilibre des variables économiques clés est traitée séparément de l'ajustement dynamique ou de la détermination à court terme. Par conséquent, les variables de choix clés sont modélisées à partir d'une structure de correction des erreurs puisqu'un tel cadre permet d'incorporer une telle approche explicitement. La structure de correction des erreurs permet de tester ou d'imposer des relations entre des variables économiques, souvent suggérées par la théorie économique, sans imposer ces relations sur la dynamique de court terme.

La mise sur pied d'un modèle incorporant des éléments valables de théorie économique et des fondations économétriques appropriées n'aurait pas été possible sans une diminution de la taille du coeur du modèle. La taille du modèle a donc été réduite substantiellement dans plusieurs secteurs alors qu'une approche, partant de l'agrégat macro-économique plutôt que de ces composantes, a été adoptée dans d'autres secteurs. De cette approche découle un modèle davantage simple et transparent qui a des propriétés qui peuvent être interprétées plus facilement par rapport à sa structure théorique. Globalement, cette approche améliore à la fois la cohérence théorique interne du modèle et sa capacité à prévoir.

# 1 INTRODUCTION

The first version of the Canadian Economic and Fiscal Model (CEFM) was designed and completed in 1986. Since then, CEFM has been used by the Department of Finance for macroeconomic forecasting and policy analysis. The model has gone through many rounds of revision since its original version. This report documents the theoretical structure of the 1996 version of the model, CEFM96. Companion papers contain up-to-date descriptions of the empirical specification, the forecast performance, and the dynamic simulation properties of this version of the model.[1]

The design of the model is constrained by the fact that it must serve two purposes: forecasting and policy analysis. This is not a trivial constraint. It is well known that a trade-off often exists between having a model that performs well in forecast mode and having one with theoretically desirable simulation properties. In addition, a main objective of the forecasting process in the Department of Finance is to predict at a fairly detailed level the outlook for federal government revenues and expenditures. As a result, CEFM96 has quite a detailed government sector. These constraints made the development of a tight theoretical model difficult. However, the 1996 version of CEFM has properties that closely approximate those of such a model.[2]

Given these objectives, we have adopted a strategy in which the determination of the equilibrium long-run value for key economic variables is treated separately from the dynamic adjustment or determination in the short run. As a result, we can model key choice decision variables within an error-correction structure since such a framework appears ideally suited for that purpose. This framework allows us to test or impose long-run relationships between economic variables, as often suggested by economic theory, without imposing these relationships on short-term dynamics.[3]

The model uses quarterly data, and most parameters are estimated, although some parameters in long-term relationships are calibrated, to be consistent with the overall theoretical structure. As Cao and Robidoux (1998) document, for key economic relationships in the model we have applied an estimation process inspired by new developments in the macroeconometric analysis of time series. In a first step, we performed unit root and cointegration tests to validate, in a statistical sense, the underlying economic model suggested by economic theory. In a second step, we used a general-to-specific approach to develop an error correction model. Finally, we checked the statistical adequacy of this model by applying diagnostic and forecasting tests.

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[1] The dynamic simulation and forecasting properties of the model are described in DeSerres,Robidoux, and Wong (1998), while estimated coefficients and related statistical tests can be found in Cao and Robidoux (1998).

[2] In addition, other general equilibrium models have been developed in the department to analyse policy changes in a more long-term perspective complementing the short- to medium-term assessment provided by CEFM96. See Harris (1988) and James (1994) for examples.

[3] However, this also means that we capture only the reduced-form dynamic embodied in the data without identifying any specific sources of that dynamic, such as adjustment costs and expectations.

We could not have built a model that embodies sound economic theory and appropriate econometric foundations without reducing the size of the core model. Thus we greatly reduced the size of the model in many sectors, while choosing a top-down approach in other sectors. This means a simpler, more transparent model, with properties that can be more easily interpreted in relation to its theoretical specification.[4] Overall, this approach improves the theoretical consistency of the model as well as its ability to forecast.

The rest of this document is structured as follows. Section 2 provides a non-technical overview of the model. Section 3 describes how households determine the optimal level of consumption and housing investment in the economy according to a utility-maximization infinite horizon framework; it also describes how the outcome of this optimization decision is approximated in the model. Section 4 defines the assumed production function for the commercial sector of the economy. This function is then used, with the profit-maximization hypothesis, to derive the determination of output, labour demand, business investment, and prices. Section 5 covers trade flows and the current account specification. Section 6 describes the specification of asset demands, the term structure of interest rates, and the nominal exchange rates. Section 7 describes the income sector. Section 8 presents the specification of the government sector, which includes federal revenues, federal expenditures, and the provincial, local, and hospital (PLH) revenues and expenditures. Section 9 provides concluding remarks. Tables at the end of the paper list calibrated and key estimated parameters, and the correspondence between the main symbols used in this text and the CEFM96 program code.

## 2 A NON-TECHNICAL OVERVIEW

This section briefly outlines the model structure. Chart 1 (at the end of the paper) schematically describes the core structure of the model. The following sections present a more detailed technical description of the model.

### 2.1 Model Structure

CEFM96 describes an economy that produces and uses two domestic goods and uses a foreign good. The two domestic goods are a commercially produced good and a non-commercially-produced good. The domestic commercial good refers to gross domestic product (GDP) at factor cost excluding non-commercial output. The non-commercial good corresponds to government wages and capital consumption allowances and private rents. The foreign good and the domestic commercial good are implicitly assumed to be a composite of many goods and services.

The economy is organized into four sectors. Profit-maximizing firms employ labour, capital, and natural resources to produce output and to supply financial instruments. Households consume the commercial and non-commercial domestic goods and the foreign good, invest in

[4] Updates and modifications to the core model are also easier.

housing, supply labour, and demand financial assets under the assumption of utility maximization. Governments collect taxes, purchase the commercial domestic and foreign goods, and supply the non-rent non-commercial goods and financial instruments. Foreigners purchase the commercial domestic good, supply the foreign good, and demand and supply financial instruments.

There are essentially three markets in the model: product, labour, and financial markets. Each market is concerned with the determination of demands, supplies, and prices. There is no real market for the non-commercial good. Income generated from the supply of that good, as well as the consequences of financing its supply, are fully integrated into the model. There is also no separate market for capital goods. The commercial domestic good and the foreign good can be used for either consumption or investment purposes by consumers, firms, or governments.

### 2.2 Product Market

The commercial domestic and foreign goods are put to a number of different uses in the model. These goods can be consumed, used for investment in residential and non-residential forms, held as inventories, or purchased by governments and foreigners. The determination of demand for the goods varies by use. The aggregate demand for the single commercial good is thus actually a composite of the aggregate demand for many individual products.

The model's structure provides a long-run solution for the demands for these goods demands. We do not, however, want to impose these long-run solutions on the short run dynamic behaviour of a given demand. Thus most of the endogenous demand functions in CEFM96 are modelled within an error-correction framework that allows the short-term path to diverge temporarily from the long-term path. The flexibility this approach provides should improve the short-term forecasting performance of the model without sacrificing its long-term properties for both forecasting and simulation exercises.

The determination of consumption is based on an infinite horizon model where households are assumed to maximize their lifetime utility under an intertemporal budget constraint. The solution to this intertemporal problem, which says that consumption equals a potentially variable proportion of total wealth, is approximated by a function relating consumption to consumer income and the real long-term interest rate. In the short run, consumption is also affected by both the slope of the yield curve and the unemployment gap. In a second step, households decide the share that is allocated to rent and non-rent consumption according to a constant elasticity of substitution (CES) aggregator function. This gives a solution for the level of housing investment similar to the solution for consumption and approximated in the same fashion. The consumption of rent and the stock of housing are then defined with accumulation rules that make them fully coherent with investment flows given some depreciation rate. Non-rent consumption is determined residually as a closing rule.

Business investment demand, which is divided between machinery and equipment and non-residential construction, is based on firms' factor demands. The demand for capital and thus investment is derived from profit maximization decisions. In the long run, the capital stock and

gross investment depend on commercial output and the user cost of capital relative to the price of the commercial domestic good. The output gap also plays a role in the short-term dynamics of business investment and capital.

Exports and imports are broken down into commodities, end products, and services. End products and services are assumed to be imperfect substitutes in both foreign and domestic markets, while commodities are assumed to be homogeneous goods with unique world prices.

On the supply side, firms maximize profits under perfect competition. The output of the commercial domestic good is determined by a Cobb-Douglas production function with constant returns to scale with respect to all inputs and Hicks-neutral technical progress. Factor inputs include labour and capital, which are assumed to be quasi-fixed in the short run but variable in the long run, and natural resources, which are assumed to be fixed in both the short and the long-run. This implies mild long-run decreasing returns to scale with respect to (long-run) variable factors, labour and capital. Potential and normal-output are two key long-term output concepts that are obtained from this production function. Potential output corresponds to the level of output that would be produced according to the production function when labour is at its potential level, capital is fully used, and technical progress is at its trend value. The difference between normal and potential output is that normal output is estimated using actual labour input rather than the potential value. To avoid confusion, the difference between actual output and potential output is called the *potential* output gap, while the difference between actual output and normal output is called the *normal* output gap.

As Helliwell and Chung (1986) suggest, actual output is determined as an endogenous factor utilization rate measured by the ratio of actual to normal output. The change in the factor utilization rate is modelled as a function of the change in the net-of-imports sales to normal output ratio, the inventory disequilibrium, the short-term profit rate, and an error-correction term. This error-correction term ensures that the utilization rate converges to one in the long run if sales, inventory, and profit are all at their long-term equilibrium values. Inventory change is derived as a residual from the difference between supply and demand for the commercial good, reflecting the closing buffering role that inventories play in the model. In the long-term, however, the level of inventory returns to its equilibrium value because disequilibria feed back in the determination of the utilization rate. In contrast to the traditional approach, which determines output from the demand side without reference to the production function, the modelling approach used in CEFM96 links the actual output to the production capabilities that are in place in the economy.[5]

Market clearing in the model comes via both quantity and price adjustments. Demand shocks in the model are first met largely by changes in imports, factor utilization, and inventories.[6] Later, however, most of the adjustment comes from prices. As long as the monetary

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[5] As a result, the change in inventories is formed residually to match the aggregate demand and supply of goods and services, while it is determined as any other demand category in the traditional approach.

[6] Although these buffers are determined simultaneously in the model, the order given here indicates the sequence in which they are used to meet unexpected short-term changes in demand. This is because we need not know the capacity utilization to solve for imports, while imports

authority cares about inflation, price pressures induce adjustments in real interest rates and the real exchange rate; in the long-term, the adjustments ensure that aggregate demand is constrained to a level of output the economy can produce on a sustainable basis. Specifically, if monetary policy is non-accommodating, excess demand, both in labour and goods and in services markets, causes an acceleration in inflation through the cost structure,[7] which puts upward pressure on real interest rates and causes nominal and real exchange rates to appreciate. This, in turn, reduces aggregate demand and returns the economy to its potential level in the long term. Thus, the model tends to push output back to its potential level in response to permanent and temporary demand shocks.

In the long run, the aggregate price level equals the unit production cost as dictated by the competitive structure of the economy. The unit production cost is given by the dual representation of the production function and is thus represented by a Cobb-Douglas index of the prices of labour, capital, and natural resources. In the short run, the aggregate price level could diverge from factor costs, allowing the profit mark-up to diverge also from the competitive equilibrium value of unity.

The transaction prices for the various components of demand in the model depend on the proportion of the foreign and domestic goods for each component as well as on the value of indirect taxes less subsidies. This holds also for export prices except for the price of commodities, which is set on the world market and is thus equal to a foreign price adjusted for the exchange rate. The same type of relationship is also used for the price of natural resources. Investment prices, which enter in the unit cost index, are modelled according to that general framework but may also deviate from their long-run values in response to excess demand or supply in the product market.

### 2.3 Labour Market

The demand for labour comes from firms producing the domestic commercial good as well as from the production of the non-commercial good. In the case of the non-commercial good, the demand for labour (for example, public sector employment) is exogenous. For commercial firms, the demand is based on the profit maximization decisions discussed above. We use the demand for labour to derive an equation for the employment rate where the rate is determined by structural and cyclical variables. Cyclical variables include reduced-form output and wage gaps,[8] and they also include the real energy price and terms of trade in deviations from their respective trends. Structural variables are an unemployment insurance generosity index and

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are used in determining the capacity utilization rate. Finally, as noted above, the change in inventories is formed residually when both actual demand and supply are determined.

[7] The unemployment gap--the difference between the natural rate and the actual rate of unemployment--affects the wage growth, while the potential output affects the growth of business investment prices.

[8] These gaps are based on first-order profit-maximizing conditions; they are reduced-form gaps in the sense that one need not know the natural rate of unemployment to calculate them. They are described more formally in subsection 4.2.

a trend unionization rate. We obtain the natural rate of unemployment by fixing cyclical gaps at their sample average values and estimated parameters at their long-run values. As a result, for a given set of estimated parameters, changes in the natural rate reflect only changes in the two structural variables--the unemployment insurance generosity index and the trend unionization rate.

The supply of labour represented by the labour force is determined in the model from an exogenous source population and an endogenous participation rate. The latter is based on fluctuations around an exogenous trend path. We determine the exogenous trend for the aggregate participation rate by trend participation rates and the composition of the source population for various age-sex categories. The deviation of the aggregate participation rate from trend is explained by the gap between the actual and the natural unemployment rates. As a result, the supply of labour, as measured by the labour force, is affected by labour market conditions in the short run, but is exogenous in the long run.

We determine the wage rate according to an expectations-augmented Phillips curve formulation relating the percentage change in the wage rate to the expected inflation rate, trend productivity growth, and the deviation of the actual rate of unemployment from the natural rate. Past and current values of the Consumer Price Index (CPI) inflation rate are used to form price expectations, while productivity growth is defined as the trend total factor productivity (TFP) growth divided by the share of labour in output. The labour market is not expected to clear in the short run; involuntary unemployment is allowed to exist. In the long run, however, the labour market is assumed to clear at the natural rate of unemployment. Therefore, there is no long-run trade-off between unemployment and inflation in the model. In the short run, wage growth adjusts to the gap between actual and natural rates of unemployment and to errors in inflation expectations. At the natural rate of unemployment, the real consumer wage will grow at a rate consistent with productivity growth.

### 2.4 Financial Markets

A few financial assets are determined endogenously in the model. They include non-interest-bearing money, interest-bearing money, life insurance assets, net claims on foreigners, and interest-bearing government bonds. Interest rates in the model can be determined from a Bank of Canada reaction function and term structure equations or can be set exogenously. Different forms of the reaction function may be employed to determine the key short-term interest rate, which is the 90-day commercial paper rate. Money supply rules or inflation rate targeting are two examples. The 90-day commercial paper rate is then used in term structure equations to determine other short-term and long-term interest rates. U.S. interest rates also play an important role in these equations.

The Canada-U.S. exchange rate is derived from a combination of purchasing power parity and the uncovered nominal interest rate parity conditions. The purchasing power parity condition provides a nominal anchor for the exchange rate in the very long-run, while the uncovered interest rate parity captures short-run deviations from the purchasing power parity condition, which can persist for long periods.

### 2.5 The Government Sector

On the fiscal side, we model the revenue and expenditure components of three levels of governments--the federal government; provincial, local, and hospital (PLH) governments; and the Canada and Quebec pension plans (CPP/QPP). The modelling of federal government revenues is more elaborate than that of the rest of the fiscal sector. Federal revenues are the sum of current revenues and capital consumption allowances. The former type of revenues includes direct taxes on persons, business, and non-residents; indirect taxes; investment income; and transfers from the personal sector.

Federal government expenditures are determined, for the most part, by budgetary processes. Therefore, we set a number of expenditure variables exogenously in nominal terms with no feedback allowed. We do, however, allow some of the expenditure variables (for example, interest payments on the public debt) to deviate from their pre-set values in response to changes in economic variables through a set of (shock minus control) simulation rules. There are two broad groupings of federal government expenditures: current expenditures and gross capital formation. Current expenditures include expenditures on goods and services, transfers to persons and non-residents, subsidies, capital assistance, transfers to the PLH governments, and interest payments on the public debt.

The PLH and CPP/QPP sectors represent a comparatively small portion of the government sector in CEFM96. In general, all provinces are considered together and there is thus no separate treatment of any individual province. The general structure of the PLH sector is similar to that of the federal government. Revenues consist of current revenues, including direct tax on persons and business, indirect taxes, transfers from persons, investment income, and transfers from the federal government, as well as capital consumption allowances. The CPP/QPP components have two sources of revenues: employee and employer contributions and investment income. Expenditures consist of benefit payments and spending on goods and services.

For both federal and PLH expenditures on goods and services, which enter directly into the calculation of GDP, there is another modelling option available in CEFM96. This alternative modelling option holds *real* government expenditures fixed at control levels. This specification, where nominal government expenditures are determined by the model but real government expenditures are fixed exogenously, is used in simulation mode.[9]

## 3 REAL HOUSEHOLD EXPENDITURES

The household sector is mainly concerned with the determination of consumption and housing investment.[10] We solve for these two main aggregates in a first step, while determining

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[9] See DeSerres, Robidoux, and Wong (1998) for an application.

[10] This section is based on Cao and Robidoux (1995).

the capital stock of housing and the consumption of rent in a second step. We determine the consumption of non-rent goods and services as a residual.

### 3.1 Theoretical Structure

We assume that a representative household with perfect foresight will solve a dynamic optimization problem and choose a path for consumption that will maximize its lifetime utility under an intertemporal budget constraint. That expected lifetime utility is given by:

$$\sum_{t=0}^{\infty} \theta^t U(C_t) \tag{3.1.1}$$

where $\theta$ is the discount factor related to the rate of time preference, $\rho$, by the following equality, $\theta = 1/(1+\rho)$, and $C_t$ is total consumption at time $t$. The utility function is assumed to have a constant intertemporal elasticity of substitution, $\sigma$:

$$U(C_t) = \frac{\sigma}{\sigma - 1} C_t^{\frac{\sigma-1}{\sigma}} \tag{3.1.2}$$

The dynamic budget constraint for the representative household is given by:

$$FW_{t+1} = (1 + rr_{t+1})(Y_t^L - C_t + FW_t) \tag{3.1.3}$$

where $FW$ denotes real net financial wealth, $Y^L$ is after-tax real labour income, and $rr$ is the real interest rate.

The household maximizes equation (3.1.1) subject to the accumulation constraint equation (3.1.3). The solution to this problem yields the following aggregate consumption behaviour:

$$C_t = \Omega_t TW_t \tag{3.1.4}$$

where

$$\Omega_t^{-1} = 1 + \frac{1}{1 + rr_{t+1}} [\theta(1 + rr_{t+1})]^{\sigma} \Omega_{t+1}^{-1}$$

$$TW_t = HW_t + FW_t$$

$$HW_t = (1 + rr_t) \sum_{t=0}^{\infty} \frac{Y_{t+t}^L}{\prod_{s=0}^{t} (1 + rr_{t+s})}$$

The solution to the optimization problem is given by equation (3.1.4) and stipulates that consumption is equal to a proportion of total wealth ($TW$), which comprises human wealth ($HW$)

and net financial wealth. The marginal propensity to consume out of wealth ($\Omega$) is a function of the real interest rate and the rate of time preference. Human wealth is measured as the present value of the future net-labour income flows.

The second household decision we model is the gross investment in residential construction. Our approach is to link this investment decision to the flow of housing services that it creates, the consumption of rent. To start, it is assumed that total consumption is a CES composite aggregate of (paid and imputed) rent consumption ($C_H$) and non-rent consumption ($C_{NH}$):

$$[\alpha_H C_H^{-\varphi} + \alpha_{NH} C_{NH}^{-\varphi}]^{-1/\varphi} \tag{3.1.5}$$

where the elasticity of substitution between these two components of consumption is given by $\sigma_H = 1/(1+\varphi)$, and $\alpha_H$ and $\alpha_{NH}$ are distribution parameters. Using the expenditure identity, $P_{H,t}C_H + P_{NH,t}C_{NH,t} = P_C C$, we get the following solution for rent consumption:

$$C_{H,t} = \alpha_H^{\sigma_H} \left( \frac{P_{H,t}}{P_{C,t}} \right)^{-\sigma_H} \Omega_t TW_t \tag{3.1.6}$$

where $P_H$ is the price of rent consumption, $P_{NH}$ is the price of non-rent consumption, and where

$$P_{H,t} = P_{IH,t}(rr_{lt} + \delta_H) \tag{3.1.6.1}$$

$$P_{C,t} = (\alpha_H^{\sigma_H} P_{H,t}^{1-\sigma_H} + \alpha_{NH}^{\sigma_H} P_{NH,t}^{1-\sigma_H})^{\frac{1}{1-\sigma_H}} \tag{3.1.6.2}$$

The rental price per unit of housing is defined by equation (3.1.6.1) where $P_{IH}$ is the price deflator for investment in residential construction, and $rr_{lt}$ is long-term real interest rate. To specify the long-term solution for investment in residential construction, equation (3.1.6) is used in conjunction with the two following identities:

$$C_{H,t} = \zeta K_{H,t} \tag{3.1.7}$$

$$K_{H,t} = (1-\delta_H)K_{H,t-1} + I_{H,t} \tag{3.1.8}$$

On the one hand, the standard link between the housing stock and the flow of services it provides to households is given by equation (3.1.7), which states that the consumption of rent equals the housing stock ($K_H$) times a subjective rental rate, $\zeta$. On the other hand, the housing stock follows the standard capital accumulation rule given by equation (3.1.8), where $\delta_H$ is the housing depreciation rate and $I_H$ is the gross investment in residential investment.

Combining equations (3.1.6) and (3.1.7), we can show that the long-term value of the housing stock is given by equation (3.1.6) divided by $P_H$. Since in the long term, $\delta_H K_{H,t} = I_{H,t}$

according to equation (3.1.8), we also know that the gross investment in residential construction is given by:

$$I_{H,t} = \frac{\alpha_H^{\sigma_H}\delta_H}{\zeta}\left(\frac{P_{H,t}}{P_{C,t}}\right)^{-\sigma_H}\Omega_t TW_t \qquad (3.1.9)$$

Having determined gross investment with equation (3.1.9), we determine the housing stock in turn by the accumulation rule equation (3.1.8). The consumption of rent is given by:

$$C_{H,t} = (1-\delta_H)C_{H,t-1} + \zeta I_{H,t} \qquad (3.1.10)$$

which is obtained by replacing $K_H$ in equation (3.1.8) by its value in equation (3.1.7). Finally, we obtain the consumption of non-rent goods and services residually as $C_{NH,t} = C_t - C_{H,t}$.

Thus, in this framework two stochastic equations determine the level of consumption as well as its composition. Equation (3.1.4) provides the solution for the optimal level of aggregate consumption, and equations (3.1.9) and (3.1.10) determine the optimal mix of rent and non-rent consumption in total consumption. The differences between the determination of total consumption and that of rent consumption are limited to the fact that rent consumption, and thus housing investment, has a lower propensity to consume out of wealth and is affected by relative price changes.

In this framework, when there is a permanent real interest rate shock, the profile of consumption (including housing investment) is affected by changes in the propensity to consume as well as by changes in total wealth. Given total wealth, higher real interest rates induce a substitution from current consumption to future consumption--this is the intertemporal substitution effect given by $\sigma$. At the same time, an increase in real interest rates means a higher rate of return on the household's assets. When $\sigma = 1$, the substitution effect exactly offsets the income effect, and the propensity to consume out of wealth is independent of the real interest rate. A rise in real interest rates also reduces the value of human wealth by discounting more future income, and thereby shifts down the whole intertemporal consumption profile. With time, however, this effect is gradually offset and at some point dominated by an increasingly higher stock of net financial wealth. The higher stock of net financial wealth is caused by a higher rate of return on assets and a potentially higher saving rate if consumption falls more than labour income in the short to medium run.

It is also worthwhile to examine how consumption will react to a temporary shock in the real interest rate. For example, we may assume that we have an economy with only one type of asset but two maturity terms: short-term maturity that yields a time-varying real return of $rr_t$ and a long-run equilibrium maturity that yields a fixed real return of $rr$. How will consumers react to variation in the short-term rate in the above framework if, in addition, the short-term return, $rr_t$, is assumed to follow a stationary process with a mean of $rr$. As Harvey (1988) shows, consumers in such a world exploit the available short-term opportunities between saving (investment) and

consumption by reducing (or increasing) consumption when the real short-term interest rate is higher (or lower) than the equilibrium rate. If net financial wealth is held constant, an increase in the short-term real interest rate should thus reduce current consumption, as does a permanent increase in the long-term rate, although the reduction should be smaller.

### 3.2 Empirical Implementation

In practice, it is not easy to introduce this wealth-based household sector empirically in a macroeconometric model like CEFM96.[11] In this version of the model, the reduced forms of consumption and investment functions derived above are estimated within an error-correction framework. In this empirical error-correction model, consumer income and the long-term real interest rate are proxies for wealth and are thus the long-term determinants of consumption and housing investment. In the housing investment function, the user cost of housing relative to the consumer price is added to the vector of long-term determinants as suggested by equation (3.1.9). In addition, the dynamics of consumption and housing investment are affected by the spread between the short-term and the long-term interest rates and the unemployment gap.

More formally, the consumption and housing investment functions are described by the following error-correction models:[12]

$$\Delta \log(C_t) = \beta_1 \Delta \log(Y_{C,t}) + \sum_{i=2}^{4} \beta_{2i} (R_{ST} - R_{LT})_{t-i} + \beta_3 UGAP_t + \beta_4 [\log(C) - \beta_5 - \beta_6 \log(Y_C) - \beta_7 RR_{LT}]_{t-1} \quad (3.2.1)$$

$$\Delta \log(I_{H,t}) = \beta_1 \Delta \log(I_{H,t-1}) + \beta_2 (R_{ST} - R_{LT})_{t-3} + \beta_3 UGAP_t + \beta_4 [\log(I_H) - \beta_5 - \beta_6 \log(Y_C) - \beta_7 (P_H / P_C)]_{t-1} \quad (3.2.2)$$

where $C$ is consumption, $Y_C$ is consumer income, $I_H$ is investment in residential construction, $R_{ST}$ is the short-term nominal interest rate, $R_{LT}$ is the long-term nominal interest rate, $RR_{LT}$ is the real long-term interest rate, $UGAP$ is the unemployment gap, and $P_H / P_C$ is the relative user cost of housing. Consumption, residential investment, and consumer income are measured on a per capita basis. The long-term value of consumption depends only on the value of consumer income and the long-term interest rate, while the long-term value of housing investments are determined by consumer income and the relative price of housing. The deviations of consumption and residential investment from their long-run values are given by the terms between the square brackets in equations (3.2.1) and (3.2.2) and are called the error-correction terms. These terms

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[11] The most difficult parts are the calculation of human wealth and the definition of the equilibrium real interest rate, $rr$, and how actual rates are linked to that rate. See Masson Symansky, and Meredith (1990) and Macklem (1994) for interesting propositions that differ from the approach we used here.

[12] In this document, $\beta_1$, $\beta_2$, ..., $\beta_i$ are used in many equations to denote estimated parameters. Obviously, these coefficients differ from one equation to another.

ensure that consumption and residential investment will always tend to return to their long-term values since $\beta_4$ is negative. The dynamic path of consumption is determined by the rate of growth of consumer income, the interest rate spread, the unemployment gap, and an error-correction term. Similarly, the rate of growth in residential investment is affected by its previous period value, the interest rate spread, the unemployment gap, and an error-correction term.

Consumer income corresponds to the expected value at time *t* of a five-year rolling regression of adjusted disposable income on a linear trend, where adjusted disposable income is defined as disposable income minus the sum of transfers from persons to non-residents and corporations, mortgage interest payments, and an inflation adjustment on net financial assets held by consumers. A real value is obtained by dividing by the consumer price deflator. Adjustable disposable income therefore corresponds, in real terms, to the net-of-taxes sum of labour and *net* interest income, the latter being evaluated at the current value of the *real* interest rate. The smoothing procedure applied on adjusted disposable income is used to reflect the fact that changes in income are assumed to be permanent only with time. Such an income measure, which approximates the flow equivalent of total wealth under constant real interest rates, must capture the effect of financial wealth and human wealth (if expectations of future labour income flows are not purely forward-looking).

As Campbell and Mankiw (1989) suggest, some individuals may not follow the wealth rule implied by the intertemporal maximization model, but may instead consume a fixed portion of their income, either because they face borrowing constraints or for other reasons. The impact on consumption and housing investment of those consumers following a simple income rule should be captured by consumer income in our reduced-form empirical framework.

The long-term real interest rate is defined as the 10-year government bond rate minus the expected inflation rate defined as a one-year moving average of the year-over-year consumer deflator inflation rate. The long-term interest rate should capture the net impact on consumption of income and substitution effects as well as the impact of changes in human wealth caused by changes in the equilibrium real interest rate. The interest rate spread is defined as the difference between the 90-day commercial paper rate and the 10-year government bond rate. As suggested above, the spread should contain information about the short-term trade-offs between investment and consumption that are available to households. Cozier and Tkacz (1994), who examine the predictive content of a number of spreads for output in Canada, conclude that this spread is one of the best.

The unemployment gap is defined as the difference between the natural rate and the actual rate of unemployment. This variable is intended to approximate the effect of consumer confidence on aggregate consumption and the changes in the number of households that face liquidity constraints over the economic cycle. The user cost of housing is calculated as the price deflator for residential construction times the sum of the depreciation rate, and the real interest rate. The real interest rate corresponds to the 10-year government bond rate minus the expected inflation rate defined as a two-year moving average of the year-over-year residential construction deflator inflation rate. In principle, both the relative user cost and the real interest rate should appear in the residential investment function. However, this approach was not producing good

empirical results because of the high correlation between these two relative prices. Since the relative user cost already includes the long-term real interest rate, the latter was dropped from the final specification.

## 4 PRODUCTION STRUCTURE

The supply side of the model is concerned with the determination of output, prices, and factor demands in the commercial sector. These key variables are all derived from the same underlying Cobb-Douglas production function that combines labour, capital, and natural resources to produce output. This production function holds in the long run but not necessarily in the short run, since factor utilization rates are allowed to vary. This structure is assumed to result from the presence of unexpected and temporary changes in demand and cost conditions and the quasi-fixity of labour and capital inputs at the firm level. The production function is thus used to derive the long-term normal values of output, inputs, and prices, but the actual values are allowed to deviate from these long-term values in the short run.

In most macroeconometric models, it is commonly assumed that labour and capital are the only primary factors. In contrast, CEFM96 also includes natural resources in the set of primary factors. In our view, natural resources clearly belong in the set of primary factors, since residual payments to factors, obtained by removing the wage bill from GDP, include not only payments to capital owners, but also rents to the owners of natural resources. In the standard two-factor model, the whole residual is typically assumed to represent capital payments, while in CEFM96 it is distributed between capital and natural resources. In addition, we have decided to model natural resources as a fixed factor in the long run. Given the calibration chosen, this implies that the production function is characterised by mild decreasing returns to scale in capital and labour. This specification is supported by the empirical results presented in Paquet and Robidoux (1997) and Robidoux (1994) and permits the introduction of the price of natural resources, and hence its impact on the aggregate price dynamics, in a theoretically consistent manner.[13]

### 4.1 OUTPUT

The commercial good produced by firms corresponds to real commercial GDP at factor cost, $Y$. It is defined as real GDP net of real consumer expenditures on rent, real government expenditures on wages, and capital consumption allowances, and net of real indirect taxes.

Firms maximize profits subject to a Cobb-Douglas production function with Hicks-neutral technical change. Output, $Y$, is assumed to be produced by capital, $K$, labour, $N$, and natural resources, $R$, under perfect competition. Labour and capital are quasi-fixed factors in the short run, but they are variable in the long run. Although natural resources are supplied to

[13] Other ways to introduce natural resources, and particularly energy, as an input in macroeconometric models have been suggested. The MACE model developed by Helliwell *et al.* (1987) is a good example. The comparative advantage of our approach is clearly its simplicity.

firms in variable quantities, they are assumed to be supplied in fixed quantities at the aggregate level even in the long-term. Formally, firms maximize profits defined as:

$$\Pi = YP - WN - UC_S K_S - UC_M K_M - P_R R \tag{4.1.1}$$

subject to the production function:

$$Y = A(N^{\alpha} K^{(1-\alpha)})^{\gamma} R^{(1-\gamma)} \tag{4.1.2}$$

$$K = K_S^{\kappa} K_M^{(1-\kappa)} \tag{4.1.3}$$

$$N = HE \tag{4.1.4}$$

where $A$ is a Hicks-neutral index of technical progress, $K_S$ and $K_M$ are the capital stocks of non-residential structure and machinery and equipment (M&E), respectively; $\kappa$ and $(1 - \kappa)$ are the shares of $K_S$ and $K_M$ in total capital stock; $H$ is yearly hours worked per employee; $E$ is the employment level; $UC_S$ and $UC_M$ are the user costs of non-residential structure and M&E capital, respectively; $W$ is the wage rate;[14] and $P$ is the GDP deflator at factor cost. This function is characterized by decreasing returns to scale in the long-term variable factors, capital and labour, since $0 < \gamma < 1$.[15]

If we take the derivatives of profits with respect to labour and capital we obtain the familiar first-order conditions for profit maximization. Substituting the production function in these conditions gives us our long-term firm's demands for labour and capital:

$$N = \alpha\gamma YP / W \tag{4.1.5}$$

$$K_S = \kappa(1-\alpha)\gamma YP / UC_S \tag{4.1.6}$$

$$K_M = (1-\kappa)(1-\alpha)\gamma YP / UC_M \tag{4.1.7}$$

We describe in subsections 4.2 and 4.3, below, how these long-term demand relationships are used in specifying the dynamic determination of employment and investment.

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[14] The wage rate corresponds to the hourly labour cost inclusive of payroll taxes paid by firms. We also use the concept of market wage rate, which is the hourly compensation received by workers before any payroll taxes paid by firms.

[15] It is well known that if the production function is a constant return to scale (CRTS) Cobb-Douglas and perfect competitionholds, then input elasticities correspond to the share of factor payments in nominal GDP at factor costs. Following this property, the parameters$\alpha\gamma$ and $\kappa$ have been calibrated to the average historical share of labour income in total income and of capital non-residential structure income in total capital income over the 1970-1990 period, respectively. The calibration of$\gamma$ was taken from the lowest estimate of decreasing returns to scale obtained by Robidoux (1994).

The total factor productivity (TFP) or Solow residual is obtained by isolating $A$ in equation (4.1.2):

$$A = Y/[(N^{\alpha} K^{(1-\alpha)})^{\gamma} R^{(1-\gamma)}] \qquad (4.1.8)$$

To calculate TFP with equation (4.1.8) we need a value for the unobservable quantity of natural resources. Since this quantity is fixed, it could be set to any value without modifying the path of TFP. For convenience, $R$ is set to 1 in this version of the model. In principle, we also want to adjust labour and capital inputs by their utilization rates, since both factors are assumed to be quasi-fixed in the short run. For capital, we make this adjustment by multiplying the capital stock by Statistics Canada's capacity utilization rate, normalized to have a mean of 1 over the 1970-1990 period. We do not adjust the labour input for variations in utilization rates, however, because there is no easy way to devise an index of labour hoarding. We obtain the trend TFP, $a$, by filtering the raw TFP series with the Hodrick-Prescott (HP) filter.

From equation (4.1.2) we define two key long-term output concepts. Potential output is the amount firms can produce when labour is at its potential level, TFP is at its trend level, and capital is fully used. Normal output is the amount that firms can produce when they are operating on their production function, given actual levels of inputs and trend TFP. Formally, we have:

$$y = a(n^{\alpha} K^{(1-\alpha)})^{\gamma} R^{(1-\gamma)} \qquad (4.1.9)$$

$$YN = a(N^{\alpha} K^{(1-\alpha)})^{\gamma} R^{(1-\gamma)} \qquad (4.1.10)$$

where $y$ is potential output, $YN$ is normal output, $a$ is normal or trend TFP, and $n$ is potential labour input defined as $he$, where $h$ is trend or normal yearly hours worked per employee, and $e$ is the potential employment level defined as the natural rate of unemployment times the trend labour force.[16]

As noted above, the production structure holds on average but not on a period-to-period basis. Marginal conditions associated with profit maximization are also expected to hold on average, but not in each period. With capital and labour as quasi-fixed factors in the short run, this implies that firms design their production process to enable them to operate over a range of feasible operating rates. They then choose factor demands and operating rates so as to maximize the present value of current and future flows of profits.[17] Higher-than-expected demand is met through a combination of inventory drawdown, increased utilization of inputs, and price increases.

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[16] See the next subsection for more details.

[17] This maximization problem could be more formally treated, by considering utilization rates as a production factor and explicitly modelling adjustment costs. The approach used here is simpler since it tries only to approximate the optimal utilization rate of quasi-fixed factors.

Actual output, $Y$, is thus modelled as a factor utilization rate decision, as measured by the ratio of actual to normal output. The factor utilization rate is assumed to be at its equilibrium long-term value when real sales, net of imports, are also at their long-term value. The change in the factor utilization rate is also assumed to be affected by inventory disequilibria and profit rates. Using an error-correction mechanism, this is modelled as:[18]

$$\Delta \log(Y_t / YN_t) = \beta_1 \Delta \log((SALES_t - M_t)/YN_t) + \beta_2 \mu_t + \beta_3 \log(K_{INVB,t} / K^D_{INVB,t}) + \beta_4 [\log(Y/YN) - \beta_5 - \beta_6 \log((SALES - M)/YN)]_{t-1} \quad (4.1.11)$$

where *SALES* is real sales, $M$ is real imports, $\mu$ is the short-term profit mark-up defined as $\log(PT_{FC}/CT)$, and $K_{INVB}$ and $K^D_{INVB}$ are, respectively, the stock of inventories and its desired or long-term value. *SALES* is defined as the sum, in real terms, of consumption excluding rent, investment, exports, and government expenditures other than capital consumption allowances and wages. The normal value of real sales net of imports is implicitly defined as $exp\ (-\beta_5/\beta_6)\ YN$. At this net sales value, actual output converges on normal output if the profit rate is at zero and the stock of inventory at its equilibrium value.

The sales term captures the effect of unexpected or temporary changes in demand conditions on the factor utilization rate. Utilization rates also move in a direction that helps to eliminate any gap between the level of inventory and its normal level. The profit rate captures the marginal cost of holding inventories. A positive pure profit rate should lead to a higher utilization rate of quasi-fixed factors and therefore lead to higher inventories for a given sales ratio.

In addition to changes in factor utilization, both inventories and imports can change to accommodate changes in aggregate demand. As shown below, imports react more in the short run than in the long run to changes in sales and, as a result, act as a buffer when the economy is facing an unexpected change in demand. Inventory change should be seen as the last buffer available to producers since it is determined residually in the model so that output is equal to the sum of final demand less imports.

Prices do not play an important role in equilibrating aggregate supply and demand in the short run,[19] but they are the main channels by which long-term sustainable levels of demand are enforced in the model. This results from the key role played by the gap between output and its potential level in determining costs and prices. With time, excess demand in product or labour markets causes, through the cost-price dynamics, an acceleration in inflation that, given a

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[18] In another approach, we could have directly adjusted labour and capital in the production function equation (4.1.2) by their respective utilization rates, as well as adjusting TFP by its actual value. That, however, would have implied explicitly modelling the capital utilization rate, the labour utilization rate, and the deviation of productivity from its trend. We use a simpler approach here in modelling all these short-term deviations from normal levels as an aggregate utilization rate.

[19] This means that for most demand shocks there are no sizeable effects on prices in the first two years; see DeSerres, Robidoux, and Wong (1998) for more details.

non-accommodating monetary rule, puts upward pressure on interest rates and hence on the exchange rate. This reduces demand and forces the economy to return to its potential. As a result, output tends to return to its potential level in response to permanent or temporary demand shocks.

### 4.2 Labour Market

This subsection describes the determination of the main labour market variables in the model.[20] These variables include the average weekly hours worked, the size of the labour force, the level of employment, and the natural rate of unemployment. The employment level is determined by the demand for labour, which is derived from the first-order conditions for the profit maximization of firms. The natural rate of unemployment is derived from the same framework. The average weekly hours worked in the commercial sector is determined from a function similar to the function for the factor utilization rate. The supply of labour, as measured by the labour force, is assumed to be exogenous in the long run but is affected by the cyclical state of the labour market in the short run.

The employment rate and the natural rate of unemployment are derived from the following equations:

$$N = \alpha\gamma YP / W \tag{4.2.1}$$

$$n = \alpha\gamma yp / w \tag{4.2.2}$$

$$er = \exp(\sum_i \nu_i Z_i) \tag{4.2.3}$$

$$ur = 1 - er \tag{4.2.4}$$

$$w / p = \alpha\gamma an^{-(1-\alpha\gamma)} K^{(1-\alpha)\gamma} R^{(1-\gamma)} \tag{4.2.5}$$

where $W$ is the hourly wage rate, $P$ is the GDP deflator, $w/p$ is the natural equilibrium real wage, $ur$ is the natural rate of unemployment, $er$ is the natural employment rate, the $Z_i$ are structural factors determining the natural rate of employment, and the $\nu_i$ are parameters. To be consistent with the production function, all variables pertain to the commercial sector.

The labour input first-order condition for profit maximization implies that actual and potential labour demands are given by equations (4.2.1) and (4.2.2). The natural rate of unemployment in equation (4.2.4) is related by an identity to the natural rate of employment, which is in turn assumed to be determined by a vector $Z$ of structural variables. The natural

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[20] The specification used, for the labour market is largely inspired by the original work of James (1991) and the further developments in Robidoux and Dea (1996).

warranted real wage described by equation (4.2.5) is derived from the first-order conditions for profit maximization when all variables are set at their potential levels. Indeed, equations (4.2.2) and (4.2.5) are two equivalent ways of writing the potential labour demand.

This framework is completed by two identities linking the labour input to employment and hours:

$$N = EH \tag{4.2.6}$$

$$n = er \cdot l \cdot h \tag{4.2.7}$$

where $E$ is actual employment, $H$ *(h)* is the actual (trend) average yearly hours worked per employee, and $l$ is the trend labour force. Labour input is thus defined as total hours, and the natural level of employment, $e$, is obtained by multiplying the natural rate of employment, $er$, by the trend labour force. Again, all these variables are measured for the commercial sector.

Taking the logarithm difference between equations (4.2.1) and (4.2.2) and using equations (4.2.3), (4.2.6), and (4.2.7) yields:

$$\log(E/l) = \sum_i v_i Z_i + [\log(Y) - \log(y)] - [\log(W/P) - \log(w/p)] - [\log(H) - \log(h)] \tag{4.2.8}$$

Removing the actual labour force on both sides of equation (4.2.8) gives:

$$\log(E/L) = \sum_i v_i Z_i + [\log(Y) - \log(y)] - [\log(W/P) - \log(w/p)] - [\log(H) - \log(h)] - [\log(L) - \log(l)] \tag{4.2.9}$$

Equation (4.2.9) describes the static theoretical relationship between the employment rate, the structural variables, and the cyclical gaps. To get an empirical specification that will better describe the dynamic behaviour of the employment rate, this specification is adjusted. First, we use a partial adjustment mechanism to describe the short run dynamic of the employment rate. Second, we add the terms of trade and the relative price of energy to the specification. Many empirical studies have identified these supply-side variables as key determinants of the Canadian unemployment rate.[21] However, the way these supply-side variables are introduced in the model means that they have only temporary effects on the employment rate. Adding these two modifications, we get:

[21] See, for instance, Burns (1990), Coe (1990), and Keil and Symons (1990).

$$\log(E/L)_t = \sum_i \nu_i^* Z_{it} + \psi_1^*[\log(Y) - \log(y)]_t - \psi_2^*[\log(W/P) - \log(w/p)]_t$$
$$- \psi_3^*[\log H - \log(h)]_t - \psi_4^*[\log L - \log(l)]_t + \psi_5^*[\log(TOT) - \log(tot)]_{t-1}$$
$$+ \psi_6^*[\log(REP) - \log(rep)]_{t-1} + \sum_i \xi_i \log(E/L)_{t-i} \qquad (4.2.10)$$

where *TOT (tot)* is the actual (trend) terms of trade, *REP (rep)* is the actual (trend) relative price of energy, and $\nu_i^*, \psi_i^*, \xi_i$ are parameters. Trends in terms of trade and energy relative prices are obtained with the HP filter.

Equation (4.2.10) is similar to a standard natural rate model, which regresses the unemployment rate on cyclical and structural variables to distinguish between these two effects. We could not estimate this equation directly, however, since potential output, *y*, and the natural warranted real wage rate, *w/p*, are themselves functions of the unobservable natural rate of unemployment. The solution proposed by James (1991) is to eliminate this circularity problem by replacing *n* and *er* by their model-consistent values in both potential output and natural warranted real wage equations. This is obtained by substituting equations (4.2.7) and (4.2.3) in equations (4.1.9) and (4.2.5):

$$\log(y) = \log(a) + \alpha\gamma[\log(l) + \sum_i \nu_i Z_i + \log(h)] + \gamma(1-\alpha)\log(K) + (1-\gamma)\log(R) \qquad (4.2.11)$$

$$\log(w/p) = \log(\alpha\gamma) + \log(a) + (\alpha\gamma - 1)[\log(l) + \sum_i \nu_i Z_i + \log(h)]$$
$$+ (1-\alpha)\gamma\log(K) + (1-\gamma)\log(R) \qquad (4.2.12)$$

We can thus obtain reduced-form by substituting equations (4.2.11) and (4.2.12) in equation (4.2.10) and collecting *Z* terms:

$$\log(E/L)_t = \sum_i \chi_i^* Z_{it} + \psi_1^* YGAPL_t - \psi_2^* WGAPL_t$$
$$- \psi_3^*[\log(H) - \log(h)]_t - \psi_4^*[\log(L) - \log(l)]_t + \psi_5^*[\log(TOT) - \log(tot)]_{t-1}$$
$$+ \psi_6^*[\log(REP) - \log(rep)] + \sum_i \xi_i \log(E/L)_{t-i} \qquad (4.2.13)$$

where $\chi_i^* = \nu_i^* - \alpha\gamma\psi_1^*\nu_i + (\alpha\gamma - 1)\psi_2^*\nu_i$, and

$$YGAPL = \log(Y) - [\log(a) + \alpha\gamma[\log(l) + \log(h)] + \gamma(1-\alpha)\log(K)$$
$$+ (1-\gamma)\log(R)] \qquad (4.2.14)$$

$$WGAPL = \log(W/P) - [\log(\alpha\gamma) + \log(a) + (\alpha\gamma - 1)[\log(l) + \log(h)] + (1-\alpha)\gamma\log K$$
$$+ (1-\gamma)\log(R)] \qquad (4.2.15)$$

The long-term relationship corresponding to equation (4.2.13) is given by:

$$\log(E/L)_t = \sum_i \chi_i Z_{it} + \psi_1 YGAPL_t - \psi_2 WGAPL_t - \psi_3[\log(H) - \log(h)]$$
$$- \psi_4[\log(L) - \log(l)]_t + \psi_5[\log(TOT) - \log(tot)]_{t-1}$$
$$+ \psi_6[\log(REP) - \log(rep)]_t \qquad (4.2.16)$$

where $\chi_i = \chi_i^* / (1 - \sum_i \xi_i)$ and $\psi_i = \psi_i^* / (1 - \sum_i \xi_i)$. The natural rate of unemployment is then given by:

$$ur_t = 1 - \exp[\sum_i \chi_i Z_{it} + \psi_1 \overline{YGAPL_t} - \psi_2 \overline{WGAPL_t} - \psi_3 \overline{[\log(H) - \log(h)]}$$
$$- \psi_4 \overline{[\log L - \log l]}_t + \psi_5 (\overline{\log TOT - \log(tot)})_t + \psi_6 (\overline{\log REP - \log(rep)})] \qquad (4.2.17)$$

where a bar over a variable indicates the sample mean of the variable. This approach ensures that the gap between the actual and the natural rate of unemployment is zero in the long run.

Before estimating equation (4.2.16), we must define the concept of commercial labour force corresponding to $L$. In this version, we arbitrarily distribute the labour force between the commercial and the non-commercial sectors according to their respective share in total employment. This means that the employment rate in both sectors equals the aggregate employment rate. Similarly, we assume that the natural-to-actual employment ratio is the same in each sector, implying that the natural rate defined in equation (4.2.17) for the commercial sector is also the rate prevailing in the non-commercial sector and in the overall economy.

This overall specification of the labour market implies also that potential and actual employment levels in the overall economy are unaffected by shocks originating in the non-commercial sector [22] Another approach would have been to assume a lower (or the absence of) cyclical sensitivity in the non-commercial or government labour market, as it is likely to be the case. Such an approach would have necessitated, however, linkages between changes in natural unemployment rates prevailing in each sector in order to preserve simulation properties, in particular, the insensitivity of potential output to changes in the government employment level.

The number of hours worked per employee per week in the commercial sector, $H$, relative to normal hours, $h$, is a function of the commercial output gap. The number of normal weekly hours worked per employee is exogenous and corresponds to the original series smoothed with an HP filter. The number of weekly hours worked per employee in the non-commercial sector is

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[22] We can show this by rewriting equation (4.2.16) as $E = \vartheta L$, where $\vartheta$ is the exponential of the right-hand side of (4.2.16), and substituting the labour force identity in it. The labour force identity can be written as $L = (LT^* \vartheta)/(E+ENC)$ where $LT$ is the total labour force and $ENC$ is employment in the non-commercial sector. After substitution and rearrangement of terms, we get $E = LT^* \vartheta - ENC$. Other things being equal, therefore, any changes in non-commercial employment, $ENC$, are offset by changes in commercial employment, $E$, leaving the total employment level unchanged.

exogenous. The economy-wide average is defined as an employment-weighted-average of commercial and non-commercial hours. Finally, growth in non-commercial employment is linked one-for-one to growth in the real government wage bill.

The supply of labour represented by the labour force is derived from an exogenous source population and an endogenous participation rate. The participation rate deviates in the short run from its long-run trend value when the unemployment rate deviates from the natural rate. The trend participation rate is determined as a population weighted-average of trend participation rates for 18 different age-sex cohorts. Trend participation rates are determined through a combination of HP filtering and judgement, where the judgement is mainly based on the available studies related to participation rates.[23]

The vector $Z$ of structural variables includes an unemployment/employment insurance generosity index and a unionization rate. The unemployment/employment insurance generosity index, *UIG*, is defined as:

$$UIG = UICOV \cdot \sum_{i=1}^{10} \beta_i UIRR_i \cdot \sum_{i=1}^{10} \beta_i UIWEEK_i \qquad (4.2.18)$$

where *UICOV* is the proportion of the labour force covered by unemployment/employment insurance;[24] $UIRR_i$ is the maximum replacement rate, defined as the maximum weekly unemployment insurance (UI) benefit one could receive divided by the average weekly wages and salaries per worker in province; and $UIWEEK_i$ is the maximum number of weeks for which a representative individual of province $i$ could receive UI benefits divided by the minimum number of weeks the same individual should work to qualify for UI. The weighting parameter, $\beta_i$ is the share of the labour force of province $i$ in the Canadian labour force. These calculations produce a *raw* index, which shows that the 1971 reform greatly increased the generosity of the UI system.[25] We assume that, in contrast to more recent changes, the first major reform of the UI system was gradually assimilated by workers and firms over a 5-year period. As a result, that initial reform was introduced linearly over the 1971Q3-1976Q3 period, while subsequent changes have been introduced more or less instantaneously in the *final* UI generosity index.

The unionization rate is calculated as the proportion of union members in the total employment. The raw unionization rate is counter-cyclical, however, since union members are less affected than the overall labour market by economic downturns. To purge this cyclical behaviour of the unionization rate, we use a trend unionization rate, which is obtained from a HP filtering of the raw unionization rate.

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[23] See MacGregor and Mang (1996) for more details.

[24] The raw covering rate is filtered with the HP filter to remove cyclical movements in labour force data.

[25] In fact, the raw index increases from 0.4 to 2.5 between 1971 and 1972.

As equation (4.2.9) shows, the use of Cobb-Douglas production function structure imposes unit elasticity between employment and output and wage gaps. This is not necessarily respected in the empirical specification equation (4.2.13). In fact, all the elasticities are estimated to be lower than 1 in this version of the model.[26] However, this has no real consequence for the theoretical consistency of the model's structure, since the potential level of the labour input, *n*, is exogenous. Examining equation (4.2.7), we note that the natural rate of employment, the trend labour force, and the average yearly hours worked per employee are all exogenous. In the long run, it is the real wage rate that is adjusting to balance the labour market. This also implies that endogenous changes in potential output in CEFM96 come only from changes in the value of the equilibrium level of capital. As we can see in equation (4.1.9), all other determinants of potential output are exogenous or determined by exogenous factors.

## 4.3 Business Investment

This subsection describes the determination of investment expenditures on non-residential construction and machinery and equipment, and how different types of user cost of capital are defined in the model.[27]

As noted in subsection 4.1 above, the assumption of profit maximization implies that the demand for the two types of capital are given by:

$$K_S = \kappa(1-\alpha)\gamma YP / UC_S \tag{4.3.1}$$

$$K_M = (1-\kappa)(1-\alpha)\gamma YP / UC_M \tag{4.3.2}$$

which relate each capital stock to output and to the relative capital price with elasticities of 1 and -1 respectively. As for the housing sector, we find better empirical results by modelling the investment flows rather than these stocks. Again we do this by exploiting the long-term relationship between capital stocks and investment flows implicitly defined by the following capital accumulation identities:

$$K_{S,t} = (1-\delta_s)K_{S,t-1} + I_{S,t} \tag{4.3.3}$$

$$K_{M,t} = (1-\delta_M)K_{M,t-1} + I_{M,t} \tag{4.3.4}$$

These results imply, in turn, that $\delta_S K_{S,t} = I_{S,t}$ and $\delta_M K_{M,t} = I_{M,t}$ in the long run. These relationships simply say that gross investment equals only capital depreciated in the previous period (no net investment) when steady-state capital, output, and price levels are reached. They imply also that

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[26] The elasticities with respect to output are given in Table 1. The coefficients of hours and labour force gaps are set to zero since in estimation they are not significant and they have the wrong sign; see Robidoux and Dea (1996) for more details.

[27] More details about theoretical and empirical specifications of this sector can be found in DeSerres(1995).

in the long-term, investment and capital functions are both characterized by unit output and price elasticities.

The dynamic investment functions can thus be defined as:

$$\Delta \log(I)_{S,t} = \beta_1 \Delta \log(Y)_{t-1} + \beta_3 YGAP_{t-1} + \beta_4 [\log(I)_S - \beta_5 - \log(Y) + \log(UC_S / P)]_{t-1} \quad (4.3.5)$$

$$\Delta \log(I)_{M,t} = \beta_1 (\log(Y)_{t-1} - \log(Y)_{t-5}) + \beta_2 \Delta \log(UC / P)_{t-1} + \beta_3 YGAP_{t-1} + \beta_4 [\log(I)_M - \beta_5 - \log(Y) + \log(UC_M / P)]_{t-1} \quad (4.3.6)$$

where $\beta_5 = \gamma\delta_S\kappa(1 - \alpha)$ in equation (4.3.5) and $\beta_5 = \gamma\delta_M(1 - \kappa)(1 - \alpha)$ in equation (4.3.6). The potential output gap (*YGAP*) is there to approximate the capacity utilization rate, which is expected to have a positive impact on the growth rate of investment.

The user costs of capital are defined as:

$$UC_M = [P_{IM,t}(1-\phi_{M,t})(1-u_t z_{M,t})(RR^I_{LT} + \delta_M)]/(1-u_t) \quad (4.3.7)$$

$$UC_S = [P_{IS,t}(1-\phi_{S,t})(1-u_t z_{S,t})(RR^I_{LT} + \delta_S)]/(1-u_t) \quad (4.3.8)$$

where $P_{IM}$ and $P_{IS}$ are price deflators for investment in M&E and non-residential construction, respectively; $\phi_M$ and $\phi_S$ are investment tax credits for investment in M&E and non-residential construction, respectively; $u$ is the corporate income tax rate; $z_M$ and $z_s$ are the present values of capital cost allowances for M&E and non-residential construction, respectively; and $RR^I_{LT}$ is the (investment) real long-term interest rate defined as the average nominal return on 10-year industrial bonds minus the expected inflation rate. The expected inflation rate is defined as a three-year moving average of the year-over-year consumer deflator inflation rate.

## 4.4 Inventory Investment

In the model, business inventory change is treated as a residual. Business inventory change ($INV_B$) is thus obtained from the identity for GDP:

$$INV_{B,t} = YT_t - C_t - I_{H,t} - I_{M,t} - I_{S,t} - G_t - INV_{G,t} - X_t + M_t - YE_t \quad (4.4.1)$$

where *YT* is total GDP, *G* is government expenditures, $INV_G$ is government inventory change, *X* is exports, *M* is imports, and *YE* is the residual error. This flow of inventory is used to calculate the stock of inventory using the standard accumulation rule:

$$K_{INVB,t} = K_{INVB,t-1} + INV_B / 4 \quad (4.4.2)$$

Such a residual specification without any other feedback mechanisms does not ensure that, in the long run, the stock of inventory converges to a desired level consistent with

underlying economic fundamentals. However, as we show above, output in the commercial sector is derived from a factor utilization rate equation relating the actual-to-normal output ratio to the actual-to-desired business inventory stock ratio, among other things. This approach ensures that in the long run, the stock of inventory returns to its desired or equilibrium level, because disequilibria, resulting from the short-term buffering role of inventory, feed back in the determination of the utilization rate and hence of output.

We must therefore develop a model to determine the desired stock of business inventory. As we do for the capital stock, we assume that the desired stock of business inventory is determined by output and a user cost. Following Rochon (1994), however, we assume that computer-related technological changes in inventory management have permanently reduced the inventory-output ratio of the 1980s. This technological change is measured by the change in the share of the U.S. capital stock of office equipment in the U.S. M&E capital stock.[28] We assume that in the 1990s, the impact of the intensive use of computers in managing inventory has been fully phased in and we therefore set this index of technological change to its value at the end of the 1980s.

The dynamic of the *actual* stock of business inventory ($K_{INVB}$) is modelled through the following error-correction model:[29]

$$\Delta \log(K)_{INVB,t} = \beta_1 \Delta \log(K)_{INVB,t-1} + \beta_2 YGAPN_{t-1} + \beta_3 [\log(K)_{INVB} - \beta_4 - \log(Y) - \beta_5 \log UC_{INVB} - \beta_6 IT]_{t-1} \quad (4.4.3)$$

where $UC_{INVB}$ is the user cost of inventory, $YGAPN$ is the normal output gap, and $IT$ is the index of technological change. The long-term *desired* stock of inventory ($K^D_{INVB}$) is then given by:

$$\log(K)^D_{INVB,t} = \beta_4 + \log(Y)_t + \beta_5 \log(UC)_{INVB,t} + \beta_6 IT . \quad (4.4.4)$$

Following Boadway, Bruce, and Mintz (1984), we define the user cost of inventories as:

$$UC_{INVB} = [R_{G10} - \pi_{INVB}(1 - ue^{-\pi_{INVB} HP_{INVB}})]/(1-u) \quad (4.4.5)$$

where $R_{G10}$ is the average yield on Government of Canada bonds 10 years and over, $\pi_{INVB}$ is the inflation rate for inventories (based on the commercial sector GDP deflator), $u$ is the corporate tax rate, and $HP_{INVB}$ is the average holding period for business inventories.

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[28] U.S. data are used since Canadian capital stock data by type of capital are not available. Rochon (1994) notes that, since Canadian and U.S. economies are closely linked, inventory management practices should be similar in the two economies.

[29] As noted above, this equation is not used *directly* in the model, since the stock of inventory is determined by the accumulation rule.

## 4.5 PRICES AND COSTS

To model prices we use a top-down approach. In this framework, the GDP deflator at factor cost is the core domestic price determined in a first step, while other price deflators are linked in a second step to that price and to import prices. Since we follow a top-down approach, we determine the price of business inventory residually to ensure that the aggregate GDP deflator is coherent with detailed final demand deflators.

We derive the long-term value for the GDP deflator at factor cost from the marginal cost function dual to the production function:[30]

$$CT = \Lambda WT^{\alpha'\gamma} PI^{(1-\alpha')\gamma} P_R^{(1-\gamma)} A \tag{4.5.1}$$

where $CT$ is the marginal production cost, $WT$ is the wage rate in the whole economy, $PI$ is a Cobb-Douglas index of investment prices, $P_R$ is the price of natural resources, and $\Lambda$ is a constant. Under perfect competition the aggregate price level equals the marginal cost given by equation (4.5.1). However, as we do for the production function, we assume this relation between the aggregate price and the marginal cost to hold in the long run but not in the short run. Instead, we describe the aggregate price dynamic by the following error correction model:

$$\Delta \log PT_{FC,t} = \sum_{i=0}^{1} \beta_{1i} \Delta \log CT_{t-i} + \beta_2 \Delta \log P_{M,t-1} + \beta_3 \log(PT_{FC} / CT)_{t-1} \tag{4.5.2}$$

where $PT_{FC}$ is the GDP deflator at factor cost and $P_M$ is the import deflator. The growth rate of import prices, which does not directly affect the GDP deflator, enters to capture the impact of foreign competition on domestic mark-ups and hence prices.[31]

Since there are only two goods in the model, the domestic and the foreign good, and $N$ final demand categories, the price of each of these final demands should be homogeneous of degree one with respect to the price of these two goods.[32] Final demand deflators identified in the model are thus determined by the following general accounting equations:

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[30] Two points are worth noting on the unit cost index. First, the cost function dual to the production function (4.1.2) is for the commercial sector, while this cost function is defined for the whole economy. It is implicitly assumed that the non-commercial sector also has a Cobb-Douglas production function but the value of the parameter$\alpha$ is allowed to be different. Under that assumption, the marginal cost function (4.5.1) is compatible with a Cobb-Douglas aggregator of commercial and non-commercial output functions where the$\alpha'$ corresponds to a weighted average of the two alphas where the weights are output shares. This approach is used because of poor empirical results obtained in explaining the short-term dynamic of the GDP deflator at factor cost in the commercial sector. Second, it is the investment price that appears in the cost index, although the user cost of capital is the appropriate price on a theoretical basis. This implies, among other things, that interest rates do not have a *direct* impact on costs and hence prices. Such an approach is appropriate in the long run if the rental rate of capital is stationary; see Robidoux (1992b) for more details.

[31] t is also common in price equations to include an output gap to capture the effect of excess demand and supply on inflation. In our structure, excess demand or supply in goods and labour markets, have an effect on the aggregate price inflation through their effect on domestic costs–wages and investment prices.

[32] This means that if both domestic and foreign good prices increase by 1 per cent, the prices of all final demand categories will also increase by 1 per cent.

$$\Delta \log(P_{j,t}^{FC}) = \sum_{i=0}^{N} \beta_{1ji} \Delta \log(PT_{FC,t-i}) + \sum_{i=0}^{M} \beta_{2ji} \Delta \log(PM_{j,t-i}) + \beta_{3j} YGAP_t$$
$$+ \beta_{4j} [\log P_{j,t-1} - \beta_{5j} \log PT_{FC,t-1} - (1 - \beta_{5j}) \log PM_{j,t-1}] \qquad (4.5.3)$$

$$P_j^{FC} = P_j / [(1 + \tau_j^I)(1 - \sigma_j)] \qquad (4.5.4)$$

where $P_j^{FC}$ $(P_j)$ is the price deflator at factor cost (at market value) of the final demand $j$, $PM_j$ is an import deflator (or a foreign price adjusted by the exchange rate) linked to the price deflator $j$, $YGAP$ is the potential output gap, and $\tau_j^I$ and $\sigma_j$ are respectively the indirect tax rate and the subsidy rate applied to final demand $j$.

Although this is the general form, the specific form used for most deflators is often simplified or modified.[33] First, for some deflators the error correction structure does not work, and a straight first-difference is used.[34] In these cases, however, the homogeneity of degree one in prices is respected by imposing that the sum of $\beta_{1ji}$ and $\beta_{2ji}$ equals 1. Second, the output gap appears only in (business, residential, and government) investment deflators. Finally, a constant is added in three equations: the deflator for business investment in M&E, the deflator for government investment in fixed capital formation, and the deflator for imported end products.[35] This accounts for the larger correction in the quality of investment goods, particularly computers, in Canadian data than in the U.S. counterpart.[36]

The wage rate for employees producing the commercial good is determined by an expectations-augmented Phillips curve. The wage rate, as measured by the hourly compensation, includes payroll taxes paid by employers. Payroll taxes correspond to employer contributions to the employment insurance, the Canada and Quebec pension plans, and provincial payroll taxes. The wage rate growth is thus defined as a function of expected inflation, trend total factor productivity growth adjusted by the share of labour income in total income, and labour market tightness. Expected inflation is measured as a weighted-average of current and past CPI inflation

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[33] This structure is used for consumer, investment, and government deflators. In the case of the aggregate consumer deflator, the GDP deflator at factor cost is net of export prices. The rent consumer deflator is determined according to equation (4.5.3), while the non-rent consumer deflator is defined residually. The consumer price index is defined as a fixed-weight index of these two consumer deflators.

[34] In addition, the deflator for rent consumption is modelled in a log-linear form.

[35] It is worth noting that although most of these equations are estimated, we tried to keep the long-term domestic and import shares in each deflator not too far away from shares simulated from an input-output model. In some cases, this leads us to constrain these shares to those obtained from the input-output model. More details on these input-output simulations can be found in Robidoux (1992a).

[36] This general structure is also used for export and import deflators. Obviously, the domestic share is set to zero for import deflators. More details will be provided in the following section describing the trade sector.

rates, while labour market tightness is measured by the unemployment gap. More precisely, we have:[37]

$$\Delta \log W_t^m = \beta_0 - \Delta \log(1 + \sum_{i=0}^{7} \tau_{t-i}^P / 8) + \sum_{i=0}^{2} \beta_{1,i} \Delta \log(PCPI_{t-i}) + \sum_{i=1}^{16} \Delta \log(a_{t-i})/16/\alpha\gamma + \beta_2 QAIB_t + \beta_3 UGAP_t \quad (4.5.5)$$

where $W^m$ is the (commercial sector) market wage rate, $\tau^P$ is the payroll tax rate, *PCPI* is the consumer price index, *a* is trend total factor productivity, *QAIB* is a dummy variable to capture the effects of the Anti-Inflation Board, and *UGAP* is the unemployment gap. In addition, the market wage rate ($W^m$) and the wage rate (*W*) are linked by the following identity: $W=W^m(1+\tau^P)$. Imposing the accelerationist hypothesis, the sum of $\beta_{1i}$ is constrained to be 1.

Equation (4.5.5) states that, in equilibrium, the real commercial-sector wage, including payroll taxes, should grow at the same pace as TFP inflated by the inverse of the share of labour income in total income. The decomposition of labour cost between market wage and payroll taxes in this equation implies also that a change in the payroll tax rate is assumed, everything else being constant, to be offset by a reduction in the market wage rate in the medium run, leaving labour costs unchanged.[38]

The market wage rate in the non-commercial sector is assumed to follow the market wage rate in the commercial sector. The wage rate for the whole economy, *WT*, is given by:

$$WT_t = (\beta_{1t} W_t^m + (1 - \beta_{1t}) WNC_t^m)(1 + \tau_t^P) \quad (4.5.6)$$

where $\beta_1$ is the share of hours worked in the commercial sector and $WNC^m$ is the market wage rate in the non-commercial sector.

The two other prices that enter directly into the unit cost index are the Cobb-Douglas index of investment prices, *PI*, and the price of natural resources, $P_R$. The investment price index uses production structure weights to aggregate the price deflators for non-residential construction and machinery and equipment. These price deflators are determined by the price structure equation (4.5.3) described above. The price of natural resources corresponds to a fixed-weight index of exogenous foreign commodity prices--food, oil, and others--adjusted for the exchange rate. The weights correspond to the relative importance of these commodities in Canadian production.[39]

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[37] We can obtain the general form of this wage equation by, first, isolating the wage rate in the labour first-order condition for profit maximization given by equation (4.1.5), and then replacing *P* by *PCPI*. We can then set labour productivity growth to $\Delta log\ (a)/\alpha\gamma$ by assuming that in the long run output and capital grow at the same pace.

[38] This hypothesis, as well as the use of the CPI inflation rate, is supported by empirical results presented in Dea and Robidoux (1995).

[39] The price of natural resources itself is defined as a fixed-weight index of Canadian agriculture, mining, forestry, and oil prices. More details can be found in Robidoux (1992a).

# 5 BALANCE OF PAYMENTS

## 5.1 TRADE FLOWS

In the previous section, we describe how economic agents determine their demands for an aggregate composite good. This aggregate good is composed of both imported and domestic goods. After having determined the level of their aggregate demand, agents must decide, in a second step, how much of this demand will be satisfied with domestic and with import goods, respectively. Thus, there should be an import demand function for each final demand category derived from an imported-domestic composite aggregator function maximized under an aggregate expenditure identity constraint. Although we do not formally model the rest of the world in CEFM96, the same relationships should hold for foreigners, leading to our export functions.[40]

Since there is no breakdown of import and export data by final demand categories, we must simplify this approach.[41] For imports, we weight each final demand category by its propensity to use imports to obtain an aggregate activity variable. For exports, the procedure is simpler; to form the aggregate activity variable we weight the total final demand for each G-6 country by the share of Canadian exports directed to the corresponding country in total exports.

Export and import functions are estimated for three categories of goods: commodities (C), end products (F), and services (S). End products and services are assumed to be imperfect substitutes in both foreign and domestic markets. Assuming also a perfectly elastic supply in both markets, this allows us to identify the traditional activity and demand price elasticities. In contrast, commodities are assumed to be a perfectly homogeneous good with a unique world price. This implies a perfectly elastic demand for our exports and a perfectly elastic supply for our imports. The level of demand in domestic and foreign markets is captured by economic activity and the price of commodities relative to the aggregate price level. As a result, export and import of commodities are affected by absolute price effects rather than relative price effects. We capture the supply price elasticity for our exports of commodities by an index of the aggregate domestic cost level relative to the price of commodities.

The general error-correction model used for export demands corresponds to:

$$\begin{aligned}\Delta \log(X)_{i,t} = & \sum_{k=1}^{2} \beta_{ki} \Delta \log(YX)_{i,t-1-k} + \beta_{3i} \Delta \log(P_{Xi} / PF_{Xi})_t \\ & + \beta_{4i}[\log(X)_t - \beta_{5i} - \beta_{6i} \log(YX)_t - \beta_{7i} \log(P_{Xi} / PF_{Xi}) \\ & - \beta_{8i} \log(PT_{FC} / (PF_C \cdot S))]_{t-1} \end{aligned} \qquad (5.1.1)$$

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[40] More on the development of the trade sector can be found in Stuart (1995).

[41] The disaggregated data on imports and exports are available only in terms of goods.

where $X_i$ is exports of category $i$ ($i$ = C, F, S), $YX_i$ is the foreign activity variable associated with exports of category $i$, $P_{Xi}$ is the price of $X_i$, $PF_{Xi}$ is an aggregate foreign price associated with category $i$ of exports, $PT_{FC}$ is the domestic GDP deflator at factor cost, $PF_C$ is a U.S. price of commodities excluding food and energy, and $S$ is the Canada-U.S. exchange rate. Foreign activities and prices are in turn defined as:

$$YX_{i,t} = \sum_{j=1}^{6} \omega_j^i \left[ \left( Y_{j,t} + (1-\eta_j) M_{j,t} \right) / \left( \overline{Y}_{j,t} + (1-\overline{\eta}_j) \overline{M}_{j,t} \right) \right] \tag{5.1.1.1}$$

$$PF_{Xi,t} = \sum_{j=1}^{6} \omega_j^i \left[ \left( Y_{j,t} + M_{j,t} \right) / \left( Y_{j,t} PY_{j,t} + M_{j,t} PM_{j,t} \right) \right] S_{j,t} \tag{5.1.1.2}$$

where $Y_j$ is the GDP of country $j$ ($j$ = 1,2...,6), $M_j$ is imports of country $j$, $PY_j$ is the GDP deflator of country $j$, $PM_j$ is the import deflator of country $j$, $\omega_j^i$ is the value-share of exports of category $i$ directed to country $j$ in total exports of category $i$ to G-6 countries, and $\eta_j$ is the share of imports from other G-6 countries in imports of country $j$. These weights are presented in Table 2.

The activity variables are roughly equivalent to the sum of the domestic final demand and exports since they correspond to the sum of GDP and imports. As Masson et al. (1990) note, since imported inputs are used in producing export goods, an increase in the latter should be associated with higher imports. We construct the activity variables to ensure that double counting of imports is avoided in aggregating countries. The calculation of the foreign price as a mirror of the activity variable allows us to capture competition coming from countries other than the G-6 through import prices.

The last term in equation (5.1.1) is there to approximate the long-run supply price elasticity for our exports of commodities. We assume that an increase in our production costs, as measured by $PT_{FC}$, or a fall in the world price of commodities in Canadian dollars reduces our supply of commodities to foreign markets. Since we assume the supply to be perfectly elastic for end products and services, this last term does not appear in the two export functions.

The general error-correction model used for import demands is:

$$\begin{aligned} \Delta \log(M)_{i,t} = & \sum_{k=1}^{2} \beta_{ki} \Delta \log(YM)_{i,t-1-k} + \beta_{3i} \Delta \log\left(P_{Mi} / PT\right)_t \\ & + \beta_{4i} \left[ \log(M)_t - \beta_{5i} - \beta_{6i} \log(YM)_t - \beta_{7i} \log\left(P_{Mi} / PT\right) \right]_{t-1} \end{aligned} \tag{5.1.2}$$

where $M_i$ is imports of category $i$ ($i$ = C, F, S), $YM_i$ is the domestic activity variable associated with exports of category $i$, $P_{Mi}$ is the price of $M_i$. Domestic activity variables are in turn defined as:

$$YM_{i,t} = \sum_{f=1}^{10} \varpi_f^i DF_f \tag{5.1.2.1}$$

where $\varpi^i_f$ is the propensity to imports goods of category $i$ by final demand of type $f$, $DF_f$, ($f$ = 1,2,...,10).

Similar to export functions, activity variables for the import functions correspond to the sum of the final domestic demand and exports. In addition, the aggregate activity variable corresponds to a weighted sum of final demand categories where the weights are final demand import propensities. These propensities to import are derived from the simulation of an input-output model of the Canadian economy, calibrated to 1985, that takes into account both direct and indirect import contents of final demands. The indirect import content is related to intermediary industrial demands.

Two dummy variables are added in the import demand function for services. The first one, *Q83*, captures an important temporary deviation in the first quarter of 1983 related to an exceptional reduction in freight shipping. The second, *Q90*, captures an assumed permanent increase in travel expenditures by Canadians outside the country in 1990.

There is a long-lasting problem in macroeconometric models of having above-unity activity elasticities in trade functions. Using current import and export weights, long-term activity elasticities are 1.13 and 1.30 for total imports and exports, respectively, in CEFM96 (see Table 1). Our aggregate import activity elasticity is lower than that historically found in the estimated Canadian demand for imports.[42] We conclude, therefore, that our approach to measuring activity for import functions,[43] as well as the use of an error-correction framework, helped in resolving the empirical puzzle of trade activity elasticities substantially above unity.[44] This conclusion is supported by the fact that activity elasticities are higher for our export functions, where we could not go as far as on the import side in modelling the activity variable.[45]

As noted above, export and import prices are determined according to the general transaction price structure described by equation (4.5.3). As for other deflators, the prices of the export of end-products and services, are affected by import and domestic prices. The import prices have no direct effect on these export prices, as for other domestic deflators, but they have an indirect effect through the production structure. Imports are used as an input to the production process, and therefore they affect the cost of producing exports. In contrast, it is assumed that

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[42] See Asseery and Peel (1991), Deyak, Sawyer, and Sprinkle (1993) and studies surveyed therein.

[43] Here both our use of GDP plus imports (rather than GDP, as traditionally used in import demand studies) and our use of weights based on propensity to import are likely to play a role.

[44] In some macroeconometric models, the problem of not having a unit activity elasticity in import or export functions implied by a simple aggregator function that would underlie these functions is resolved by imposing it; see Masson et al. (1990) for example. Here we do not impose these unit elasticities because we think that the simulation properties of the model will not be dramatically changed by imposing this constraint, since we are not too far away from it, while a significant loss is expected on the forecasting performance. Our export and import demand functions should thus be seen as being loosely derived from CES aggregator functions, where the presence of a unit elasticity of activity is relaxed because of measurement problems.

[45] We did not pursue the idea of developing input-output models for the G-6 countries, although that approach would be feasible.

exporters of commodities are price takers, and, as a result, we determine the price deflator for exports of commodities only by foreign commodity prices adjusted for the exchange rate. We use the same approach for the price of imported commodities, while the price deflators for imported end products and services are linked to more aggregate foreign prices adjusted for the exchange rate.

## 5.2 Current Account

Trade flows form part of the structure for estimating net international indebtedness within CEFM96. Other required items include estimates of service payments and receipts and current account balances. Once these items are determined, estimates of foreign assets and liabilities can be obtained through cumulating current account balances.

The payments of interest income and dividends to foreigners are calculated as:

$$IP_M = R_M KI_L \tag{5.2.1}$$

where $IP_M$ is nominal interest income and dividend payments to foreigners, $R_M$ is the implicit rate of return on domestic assets held by foreigners, and $KI_L$ is the stock of domestic assets held by foreigners. The implicit interest rate is linked to domestic interest rates through an error-correcting mechanism:

$$\begin{aligned}\Delta R_{M,t} = {} & \beta_1 \Delta\left(\sum_{i=1}^{40} R_{LT,t-i}/40\right) + \beta_2 \Delta R_{G13,t} + \beta_3 \Delta R_{M,t-4} \\ & + \beta_4 \left[ R_{M,t-1} - \beta_5 - \beta_6 \left(\sum_{i=1}^{40} R_{LT,t-i}/40\right) - \beta_7 \Delta R_{G13,t-1} \right]\end{aligned} \tag{5.2.2}$$

where $R_{LT}$ is the average yield on Government of Canada bonds with terms to maturity of 10 years and over, and $R_{G13}$ is the average yield on Government of Canada bonds with terms to maturity of 1 to 3 years.

The receipts of interest income and dividends from foreigners are calculated as in equations (5.2.1) and (5.2.2):

$$IP_X = R_X KI_A \tag{5.2.3}$$

$$\begin{aligned}\Delta R_{X,t} = {} & \beta_1 \Delta\left(\sum_{i=1}^{12} R_{t-i}/12\right) + \beta_2 \Delta\left(\sum_{i=3}^{14} R^{US}_{G10,t-i}/12\right) \\ & + \beta_3 \left[ R_{X,t-1} - \beta_4 - \beta_5 \left(\sum_{i=1}^{12} R^{US}_{G3,t-i}/12\right)_{t-1} - \beta_6 \left(\sum_{i=1}^{40} R^{US}_{G10,t-i}/40\right)_{t-1} \right]\end{aligned} \tag{5.2.4}$$

where $IP_X$ is nominal interest income and dividend received from foreigners, $R_X$ is the implicit rate of return on foreign assets held by Canadians, $KI_A$ is the holding of foreign asset stock by Canadians, $R_{G3}^{US}$ is the average yield on U.S. government bonds with terms to maturity of 1 to 3 years, and $R_{G10}^{US}$ is the average yield on U.S. government bonds with terms to maturity of 10 years and over.

The current account balance is calculated using the identity:

$$CA = (X^N - M^N) + (IP_X - IP_M) + NXTR + NIM + NRET \tag{5.2.5}$$

where $CA$ is the current account balance, $X^N$ - $M^N$ is nominal net exports, $IP_X$ - $IP_M$ is net interest income and dividends payments, $NXTR$ is net transfers, $NIM$ is net immigrant funds, and $NRET$ is net retained earnings. Net transfers are determined elsewhere in the model, and net immigrant funds and net retained earnings are set exogenously. Current account balances are then cumulated to give a measure of net international indebtedness. This is given by:

$$NA_t = NA_{t-1} + CA_t \tag{5.2.6}$$

where $NA$ is net foreign asset. A current account surplus will therefore increase net foreign assets, while a current account deficit will decrease them.

By definition, the difference between the stock of foreign assets held by domestic residents and the stock of domestic assets held by foreigners is net foreign assets.[46] Hence, with net international assets determined by equation (5.2.6), the stock of foreign assets held by domestic residents, $KI_A$ in equation (5.2.3), is determined as:

$$KI_{A,t} = NA_t + KI_{L,t}. \tag{5.2.7}$$

The stock of domestic assets held by foreigners, $KI_L$, is linked to the current account balance through:

$$\Delta KI_{L,t} = \beta_1 + \beta_2 CA_t \tag{5.2.8}$$

This specification of the balance of payments thus allows stock-flow interactions between trade flows, interest and dividend payments, and net international assets. Any improvements in the trade account improves the current account balance, which in turn leads to increases in net foreign assets. The resulting increases in the stock of foreign assets held by domestic residents and the decreases in the stock of domestic assets held by foreigners reduce net interest and dividend payments to foreigners, thus improving the current account balance.

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[46] The gross stock of assets is used as an input in the corporate income tax sector and in the calculation of National Income Accounts identities.

# 6 FINANCIAL MARKETS

The financial markets block models the demand for financial assets, the term structure of interest rates, and exchange rates. Interest rates and financial assets from this block are primarily used to calculate interest income and debt interest payments, thereby providing an important link between the real and the financial sectors of the model. Exchange rates in this block consist of Canada vis-à-vis the other G-6 exchange rates, and G-9 and G-10 trade-weighted exchange rates.

## 6.1 FINANCIAL ASSET DEMANDS

Financial assets consist of non-interest-bearing money (M1), interest-bearing money (M2), fixed-term deposits, non-chequable savings deposits, life insurance assets, and Canada Savings Bonds.[47]

The demand-for-real-M1 equation is a standard money-demand function with a partial adjustment mechanism. The two main determinants of real M1 demands are the 90-day commercial paper rate, which is used to measure the opportunity cost of holding M1, and real GDP, which is used to proxy expenditures. Dummy variables are used to account for shifts in M1 owing to financial market innovations. The M1 equation is used as an interest rate rule in simulation and forecast modes when the money supply is assumed to grow at a given exogenous rate. The inverted long-run demand function then becomes an interest rate rule, and the 90-day commercial paper rate is solved endogenously.

The demand for real M2 is modelled in a similar fashion to the demand for real M1. Unlike M1, this broader monetary aggregate does offer a rate of return to its holders. Therefore, two interest rates are used in the M2 equation: one to capture the opportunity cost of holding M2 instead of other types of interest-bearing assets, and the other to proxy its own rate of return. Since the Canada Savings Bond is a close substitute to most components of M2, it is used to capture this substitution effect, while the opportunity-cost effect is assumed to be captured by the 90-day commercial paper rate.

The demand for life insurance assets depends on the difference between M2 and M1 and on the rate of return associated with this type of asset. The difference between M2 and M1 is a proxy for funds available for the purchase of life insurance assets by households.

Both the demand for fixed-term deposits and the demand for non-chequable deposits are modelled on three main variables: an income variable, an interest rate variable representing the opportunity cost of holding the associated deposit, and an interest rate variable representing the deposit's own rate of return. The demand for Canada Savings Bonds is exogenous to CEFM96.

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[47] There are other financial assets in the model, most of which are documented in the government sector or the balance of payment sections.

## 6.2 Interest Rates

Because CEFM96 consists of a limited number of financial assets, interest rates are not determined through financial market clearing conditions. Instead, they are derived from the term structure of interest rates. There are 18 interest rates in the model, the most important being the 90-day commercial paper rate. Assuming some path for M1 money supply, this interest rate is solved endogenously using the inverted long-run M1 demand function. Obviously we could use other monetary policy rules in the model. For example, one can assume that the monetary authority allows a reaction function that links the changes in the 90-day commercial paper rate to changes in the inflation rate. Other important, but exogenous, determinants in the term structure are U.S. interest rates. The inclusion of U.S. interest rates acknowledges the fact that Canada is a small open economy and that the interest rate movements are significantly affected by movements in world interest rates. Once the 90-day commercial rate is determined and U.S. interest rates are given, we can derive all other interest rates recursively.

## 6.3 Exchange Rates

The model contains 10 exchange rates. They include the exchange rate of the Canadian dollar vis-à-vis the U.S. dollar, the Japanese yen, the German mark, the U.K. pound, the French franc, the Italian lira, and the G-10 and G-9 (excluding the U.S.) trade-weighted currencies. Also included are the exchange rates of the U.S. dollar vis-à-vis the trade-weighted G-15 and G-14 (excluding Canada) currencies. Of these rates, the Canada-U.S. exchange rate is the most important external price in the model. This exchange rate is modelled separately while all other trade-weighted exchange rates are modelled on the exogenous U.S. - G-14 trade-weighted exchange rate.

The nominal Canada-U.S. exchange rate in CEFM96 is modelled on a combination of purchasing power parity and uncovered interest rate parity conditions. The purchasing power parity rule provides a nominal anchor for the exchange rate in the long run, while the uncovered interest rate parity condition, captures short run deviations from the purchasing power parity condition. The use of both the purchasing power parity and the interest rate parity conditions to develop reduced-form exchange rate equations is common. Dornbusch's (1976) exchange rate over-shooting model and Frenkel's (1979) real interest rate models, are early examples. More recently, this single-equation approach has evolved into the multivariate system approach in Johansen and Juselius (1992).

In contrast to the monetarist assumption of complete price flexibility, the use of the two parity conditions is based on the assumption that prices are sticky in the short run, responding only gradually to excess demand and supply in the goods market. Although the equilibrium exchange rate is determined by relative prices in the long run, it is the movements in the asset prices that dictate short run exchange rate dynamics. The asset market clears as a result of movements in interest rates, and the exchange rate maintains this equilibrium in the asset market by always moving to make sure the uncovered interest parity condition is satisfied. In the short run, since prices are more or less given, the exchange rate determines our position of international competitiveness. Our international competitiveness position, together with the

interest rate, which clears the money market, helps to determine the demand for domestically produced goods. Domestic prices then respond to excess demand or supply of goods. This movement in prices feeds back to our relative international competitiveness, and the economy moves towards a long-run equilibrium where the supply and demand for goods are in balance and the purchasing power parity holds. This mechanism implies that the exchange rate is not just a monetary phenomenon. Both real and monetary factors are important in determining its behaviour. Changes in real factors that affect the real side will also affect the exchange rate.

The purchasing power parity condition is given by:

$$P_t = S_t \cdot P_{f,t} \tag{6.3.1}$$

where $P_t$ is the domestic price, $S_t$ is the nominal exchange rate expressed as units of domestic currency per unit of foreign currency, and $P_{f,t}$ is the foreign price. Equation (6.3.1) states that the equilibrium exchange rate equalizes common-currency prices, and thus the purchasing power of both domestic and foreign currencies, when expressed in common units. If this were not the case, asset holders in both countries would adjust their demand for the two currencies on the foreign exchange market until their purchasing powers were equalized.

The uncovered interest rate parity is given by:

$$i_t - i_{f,t} = E\log(S_{t+1}) - \log(S_t) \tag{6.3.2}$$

where $i_t$ is the domestic interest rate, $i_{f,t}$ is the foreign interest rate, and $E(S_{t+1})$ is the expected value of the exchange rate at time $t+1$ formed at time $t$. Equation (6.3.2) states that the interest differential between two identical financial assets should be exactly offset by the expected rate of change in the exchange rate.

To combine the purchasing power parity and the uncovered interest rate parity conditions, equation (6.3.1) must be transformed in terms of the expected exchange rate:

$$E\log(S_{t+1}) = \log(P_t) - \log(P_{f,t}). \tag{6.3.3}$$

Substituting equation (6.3.3) into equation (6.3.2) gives:

$$\log(S_t) = \log(P_t) - \log(P_{f,t}) - (i_t - i_{f,t}) \tag{6.3.4}$$

Equation (6.3.4) is the basis of the Canada-U.S. exchange rate equation in CEFM96. Allowing energy prices to have short-term influences on exchange rate movements, the exchange rate equation is given by:

$$\log(S_t) = \beta_0 + \beta_1 \log(S_{t-1}) + (1-\beta_1)\left[\log\left(\sum_{i=0}^{5} PT_{t-i}\right) \Big/ \log\left(\sum_{i=0}^{5} PT^{US}_{t-i}\right)\right]$$
$$+ \beta_2 (R_{ST,t} - R^{US}_{ST,t}) + \beta_3 \log\left[REXP_t \Big/ \left(\sum_{i=1}^{2} REXP_{t-i}\right)/2\right] \qquad (6.3.5)$$

where $PT_{US}$ is the U.S. GDP deflator, $PT$ is the Canadian GDP deflator, $R_{ST}$ is the Canadian short-term interest rate, $R^{US}_{ST}$ is the U.S. short-term interest rate, and $REXP$ is the price deflator for energy exports relative to the consumer deflator. When short-term interest rates in Canada and the United States are the same, equation (6.3.5) reduces to the purchasing power parity condition. Note that in CEFM96, the exchange rate equation requires only relative, not absolute, purchasing power parity to hold in the long run.[48]

The exchange rates for Canada vis-à-vis other G-6 countries are modelled on the exogenous U.S. trade-weighted exchange rates vis-à-vis those G-5 countries:

$$\frac{S_{i,t}}{S_{i,t-1}} = \frac{\left(S_t / S_{t-1}\right)}{\left(SG_{5,t} / SG_{5,t-1}\right)} \qquad (6.3.6)$$

where $SG_5$ is the U.S. trade-weighted exchange rate vis-à-vis the G-5 countries, and $S_i$ represents the ith country's exchange rate with Canada.

## 7 INCOME FLOWS

The income block models and defines the components of domestic and national income and personal and corporate income, using variables determined in other sectors of the model. Most equations in this block are identities and adding-up constraints, some of which are designed to ensure the equality between national income and expenditure flows.

### 7.1 Domestic and National Income Flows

In the National Income and Expenditure Accounts, income and expenditure flows are always equal. To guarantee that we satisfy this constraint in CEFM96, we determine corporate profits before taxes on a domestic product basis residually by the following identities:

$$Y^N_{PROFIT} = Y^N_{ND} - Y^N_{WAGE} - Y^N_{INT} - Y^N_{INV} - Y^N_{NF} - Y^N_{WB} - Y^N_{UB} \qquad (7.1.1)$$

[48] Relative purchasing power parity is given by $\Delta\log(S) = \Delta\log(P) - \Delta\log(P_f)$. Since data on prices are mainly in indices, most empirical work requires only relative purchasing power parity to hold.

$$Y_{ND}^{N} = Y^{N} - Y_{CCA}^{N} - (TI^{N} - SUB^{N}) - Y_{ERROR}^{N} \qquad (7.1.2)$$

where the superscript $N$ denotes a nominal variable, $Y_{PROFIT}$ is the corporate profits before taxes on a domestic product basis, $Y_{ND}$ is net domestic income at factor cost, $Y_{WAGE}$ is labour income (including military pay and allowances), $Y_{INT}$ is total interest and miscellaneous investment income, $Y_{INV}$ is an inventory valuation adjustment, $Y_{NF}$ is net farm income, $Y_{WB}$ is an adjustment on grain transactions, $Y_{UB}$ is net income of non-farm unincorporated business, $Y$ is nominal GDP, $Y_{CCA}$ is total capital consumption allowances, $TI$ is total indirect taxes, $SUB$ is total government subsidies, and $Y_{ERROR}$ is a statistical discrepancy. Using corporate profits before taxes as a residual item, equations (7.1.1) and (7.1.2) together guarantee that the income and the expenditure sides of CEFM96 are equalized.

Some components of equations (7.1.1) and (7.1.2) are defined within the income block. These components include total interest and miscellaneous investment income, the inventory valuation adjustment, net income of non-farm unincorporated business, total capital consumption allowances, labour income, and GDP. The rest are either defined in other parts of CEFM96 or are set exogenously.

The relationship between gross domestic product and gross national product is given by:

$$Y_{GNP}^{N} = Y^{N} + IP_{X} - IP_{M} \qquad (7.1.3)$$

where the superscript $N$ denotes a nominal variable, $Y_{GNP}$ is nominal gross national product, $IP_X$ is nominal interest and investment income received from foreigners, and $IP_M$ is nominal interest and investment income paid to foreigners.

Other key definitions of national income variables are specified in this block. Real GDP at market prices ($YT$) is defined as:

$$Y = YC + \frac{C_H}{((1+t)\cdot(1-sr)} + GW + (TI - SUB) + GCCA + Y_{ERROR\,86} \qquad (7.1.4)$$

where $Y$ is the GDP in the commercial sector, $C_H$ is rent consumption, $t$ is the value in 1986 of the indirect tax rate on rent consumption, $sr$ is the value in 1986 of the subsidy rate on rent consumption, $GW$ is real government expenditures on wages, $TI$ is real indirect taxes, $SUB$ is real government subsidies, $GCCA$ is real government capital consumption allowances, and $Y_{ERROR86}$ is an exogenous statistical discrepancy.[49]

Finally, real GDP at factor cost ($YT_{FC}$) and real GNP are given, respectively, by the following identities:

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[49] The calculation of real indirect taxes and real government subsidies in the model follows the methodology determined by Statistics Canada; see Robidoux (1992a) for more details.

$$YT_{FC} = Y - TI + SUB \tag{7.1.5}$$

$$Y_{GNP} = Y + (IP_X^N - IP_M^N)/PT \tag{7.1.6}$$

where $PT$ is the GDP deflator. The nominal values of these real expenditure items are found by multiplying them by their deflators.

## 7.2 Personal and Corporate Income Flows

Most personal income variables determined in the personal and corporate income block are expressed in nominal terms. They include interest and investment income and transfer payments from various sources. Since interest and investment income variables are derived as products of interest rates and financial asset stocks, they are important links between the financial sector and the real sector in CEFM96. Changes in monetary policies and hence in interest rates have not only a direct substitution effect on household expenditures, but also an indirect effect through changes in personal income.[50]

Interest and investment income is made up of bond interest income, investment income from life insurance companies, investment income from foreigners, and other interest income. Investment income from life insurance companies and other interest income are calculated as a product of interest rates and the appropriate financial assets; bond interest income is determined by government interest payments on the public debt; and investment income from foreigners is modelled on dividends received from foreigners.

One important variable in the personal sector is personal income. It is defined as the sum of interest, dividends, and investment income; labour income; transfers from governments; CPP/QPP benefits; capital assistance from governments; transfers from businesses and foreigners; net farm income; and net income of non-farm unincorporated business. Personal income is used in the calculation of consumer income,[51] which is a main determinant of real household expenditures. Personal disposable income is defined as personal income less the sum of total direct taxes paid, contributions to the CPP/QPP plans, and transfers to governments.

Corporate income variables represent only a small part of the income block, consisting of corporate profits before and after taxes, dividend payments to foreigners, and undistributed corporate profits.

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[50] See Section 3 for more details on the relationships between income, interest rates, and household expenditures.

[51] See subsection 3.2 for more details.

# 8 GOVERNMENT SECTOR

The government sector models the revenues and expenditures of three levels of government: (1) federal; (2) provincial, local, and hospital (PLH); and (3) the Canada and Quebec pension plans (CPP/QPP). In CEFM96, the modelling of federal government revenues is more elaborate than the modelling of the PLH and CPP/QPP revenues, and the interaction between federal revenues and the real sector of CEFM96 is also more pronounced. Federal government expenditures, however, are mostly dictated by budget measures, and the feedback from the real side of the economy is less prominent. The PLH and CPP/QPP sectors represent a comparatively small portion of the government sector in CEFM96.

## 8.1 Federal Revenues

Federal revenues correspond to current revenues--that is, the sum of direct tax on persons, direct tax on business, indirect taxes, investment income, direct tax on non-residents, transfers from the personal sector, and capital consumption allowances.

### *8.1.1 Direct Taxes on Persons*

Direct tax on persons includes personal income tax, unemployment insurance contributions, the estate tax, and employer/employee contributions to federal pension funds. Both the estate tax and employer/employee contributions to federal pension funds are exogenous to CEFM96.

#### *Personal Income Tax*

The structure of the personal income tax block in CEFM96 follows that of the T1 tax return, taking its data from Revenue Canada's Taxation Statistics publication. A system of equations[52] links items from the T1 tax return to variables determined elsewhere in the model to provide forecasts of basic federal tax and personal income tax collections on a national accounts basis.

First, the total number of taxable filers is determined using two main variables from elsewhere in the model: labour force employment and the population aged 65 and over. The assessed income of these filers from different taxable sources is estimated using relevant variables from other sectors of CEFM96. Examples of these taxable income sources are wages and salaries, unemployment insurance benefits and old age security pensions. The sum of these different income sources gives the total income assessed. Various deductions from total assessed income are allowed under the *Income Tax Act*--for example, registered retirement pension plan contributions and child care expenses. The difference between the estimated total assessed income, and the total deductions gives an estimate of taxable income.

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[52] See Rodgers (1992).

The second step is to calculate indexation factors for non-refundable tax credits and taxable income brackets. Non-refundable tax credits (for example, the basic personal credit, unemployment insurance premiums, and CPP/QPP contributions) are calculated on the basis of the tax code together with the indexation factors and variables determined elsewhere in the model. The 1988 tax reform has reduced to three the number of taxable income brackets to which federal marginal tax rates are applied. Since 1986, tax brackets have been only partially indexed.

The next step is to calculate the basic federal tax. The basic federal tax is the total federal income tax on taxable income after a deduction for non-refundable tax credits and the dividend tax credit, but before deducting the abatement for Quebec income tax and before adding the high-income and general surtaxes. The personal income tax block calculates the basic federal tax for six income ranges. For each income range, the tax code is applied to the average taxable income of a representative filer to determine the filer's average basic federal tax. It is then multiplied by the number of taxable filers in each income group to arrive to the basic federal tax for the group. The aggregate of the estimated basic federal tax across the six income ranges less any dividend tax credits and non-refundable tax credits gives the total basic federal tax.

The total basic federal tax is then adjusted for federal surtaxes, forward-averaging, minimum tax, foreign tax credit, investment tax credit, and the Quebec abatement to get an estimate of the total net federal tax payable. Finally, federal personal income tax collections on a national accounts basis are derived by adjusting the net federal tax payable for lags in collections.

*Unemployment Insurance Contributions*

Employer and employee contributions to the unemployment insurance fund are calculated using statutory rates and an estimated income base. The income base is modelled on the portion of employment covered by unemployment insurance, maximum insurable earnings, and average labour income. Allowances are also made to account for the phasing in of unemployment insurance provisions following the 1971 reforms.

### *8.1.2 Direct Taxes on Business: The Corporate Income Tax*

Data for the corporate income tax block of CEFM96 are based on Revenue Canada, Taxation's *Corporation Sample Summary Statistics*, which are derived from T2 corporate income tax forms. The key variables determined by this block[53] are corporate taxable income (that is, the tax base) and federal corporate tax liabilities (after applying the tax rate and adjusting for surtaxes and tax credits).

The main determinant of corporate taxable income is corporate profits before taxes from the income block of CEFM96. However, several adjustments, reflecting the allowances and

[53] See Will (1996) for a detailed description.

requirements under the *Income Tax Act*, are needed to establish the linkage between corporate taxable income and corporate profits before taxes. Much of the corporate income tax block is devoted to specifying these adjustment items. Because of the large number of possible adjustments, not all adjustments are modelled explicitly in the corporate tax block. The adjustments that are modelled are chosen for their relative importance in terms of size and for how easily they can be explained by other variables determined in CEFM96. Adjustments that are explicitly modelled are current-year losses, prior-year losses, exploration and development expenses for book and tax purposes, the depletion allowance, the resource allowance, provincial royalties, depreciation for book and tax purposes, and net capital gains.

Many adjustment items needed to link corporate profits before taxes to corporate taxable income are deductions from stocks that carry over from one taxation year to the next. The general method by which these deduction (and addition) items are modelled is as follows. First, the stock of deductions available to be claimed in the year is calculated. A rate of lapse is applied to the stock of deductions carried over from the previous year to account for reductions to the stock owing to factors such as the expiry of deductions and bankruptcies. Current-year additions to the stock are estimated, and then, if available for use in the year they are produced, are added to the stock to estimate the stock available for use. An estimated utilization rate of the stock of deductions is then applied to the stock of deductions available for use, to estimate the use of deductions for the year. This estimated use of deductions is then subtracted from the stock to calculate the stock of deductions available to be carried over to the next year. This process is repeated for each year to estimate the evolution of the stock over time.

Eleven addition and deduction items are modelled in the corporate income tax block. After these items are estimated, corporate taxable income is calculated by adding these items to, or subtracting them from, to corporate profits before taxes.

The final step is to estimate federal corporate income tax liabilities--that is, the amount of tax on profits owed to the federal government by corporate enterprises. This is calculated by applying the weighted-average federal corporate income tax rate and the corporate surtax to corporate taxable income, and adding the large corporations tax and miscellaneous income and capital taxes net of various tax credits allowed under the *Income Tax Act*.

### *8.1.3 Indirect Taxes*

There are several indirect taxes in CEFM96. Some of them, such as the oil export charge, the petroleum compensation charge, the natural gas and gas liquids tax, and the manufacturer's sales tax, no longer exist but are included in the model for reference.

The indirect tax block comprises about 30 equations, half of which are devoted to calculating effective indirect tax rates for different final demand categories. The rest of the equations are used to calculate different indirect tax revenues. Effective indirect tax rates are an important input in the calculation of tax revenues and are also used in the determination of market prices in the economic side of CEFM96.

The general form used to calculate effective indirect tax rates is:[54]

$$1+\tau_i^I = (1+\tau_{GST}\cdot\rho_{i,GST})(1+\tau_{PROV}\cdot\rho_{i,PROV}+\tau_{i,FUEL}+\tau_{i,GAS}+\tau_{i,RES})$$

where $\tau^I_i$ is the effective tax rate for final demand category $i$, $\tau_{GST}$ is the goods and services tax (GST) rate, $\rho_{i,GST}$ is the proportion of the final demand expenditure $i$ subject to the GST, $\tau_{PROV}$ is the weighted-average provincial sales tax rate, $\rho_{i,PROV}$ is the proportion of the final demand category $i$ subject to the provincial sales taxes, $\tau_{i,FUEL}$ is the effective motive fuel tax rate levied by the provinces on final demand category $i$, $\tau_{i,GAS}$ is the effective federal gasoline tax rate levied on the final demand category $i$, and $\tau_{i,RES}$ is the effective tax rate associated with other indirect taxes levied on the final demand category $i$.

*Goods and Services Tax*

The most important source of indirect tax revenue is the goods and services tax. In the indirect tax block, GST revenues are calculated as the product of the tax rate and an estimated tax base.[55] The tax base is specified as the product of the value of sales to final consumers and the proportion that is subject to the GST. Data for constructing the taxable proportions are obtained from the simulation of an input-output model of the Canadian economy. To derive the tax base, we must adjust gross expenditures in each final demand category to exclude those items that are not subject to the GST as well as the GST itself. These adjusted gross expenditures are then aggregated to match the final demand categories in CEFM96.

Two categories are treated differently in calculating GST revenues. Under the current tax system, municipalities, hospitals, universities, and provincial governments receive either partial or full rebates of the GST they pay on their goods and services and investment expenditures. Separate tax base and rebate equations are specified specially for this group. Another category that receives a partial rebate is the sale of newly constructed (or substantially renovated) homes. A separate rebate equation is also needed to account for those.

As noted above, once the tax basis, the taxable proportions, and special tax treatments are defined, the amount of the total GST revenues is derived as the product of the GST rate and the tax base. The steps needed to calculate the GST revenues are summarized by the following equations:

$$BASE_{GST} = \sum_i \frac{\rho_{i,GST} FD_i}{(1+\tau_{GST}\cdot\rho_{i,GST})}$$

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[54] The effect of the manufacturers' sales tax and some special treatment of indirect taxes are ignored here for purposes of expositional.

[55] See Department of Finance (1991a) for more details.

$$R_{GST} = \tau_{GST} \cdot BASE_{GST} - REBATE_{PLH} - REBATE_{HOUSE}$$

where $BASE_{GST}$ is the GST tax base, $FD_i$ is final demands category $i$, $R_{GST}$ is the revenues from GST collection, $REBATE_{PLH}$ is the rebate to provincial governments, municipalities, hospitals, and universities, and $REBATE_{HOUSE}$ is the rebate on newly constructed homes.

*Other Indirect Taxes*

The other indirect taxes included in the model are the motive fuel excise tax, customs import duties, excise duties and taxes, and the airport tax.

The motive fuel excise tax is a specific tax on motive fuels (on a per litre basis) levied at the refinery.[56] Tax revenues are calculated as the product of the tax rate and an estimated tax base. Two tax rates are used to calculate the revenues, since non-commercial users pay 1.5 cents more per litre than commercial users. The tax base is defined as the net sales of fuels in Canada, measured in megalitres. The base includes the net sales of motor gasoline, diesel, and aviation turbo fuels at the refinery level.

Customs import duties are calculated as the product of the average effective duty rate on imports and an estimate of the tax base.[57] The average effective duty rate is calculated as the ratio of customs import duties to the estimated tax base, but adjusted for the impact of bilateral tariffs under the Canada-U.S. Free Trade Agreement, and other major trade policy initiatives. The proxy tax base is defined as total imports of goods excluding petroleum products. Excise duties and taxes are estimated as the product of effective rates and final demand categories.[58] When the tax rates are calculated, alcohol and tobacco products are treated separately since they are taxed at higher rates than other items. Finally, the airport tax is exogenous to CEFM96. As noted above, other indirect taxes in the model have expired, but they are kept for reference.

### *8.1.4 Other Revenues*

Other sources of revenues that are modelled explicitly in CEFM96 are investment income, direct taxes on non-residents, current transfers from persons, and capital consumption allowances.

Investment income includes remitted interest payments on federal government bonds and treasury bills held by the Bank of Canada, remitted profits of government business enterprises,

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[56] See Department of Finance (1991b) for more details.

[57] See Séguin (1990a) for more details.

[58] See Séguin (1990b) and Fortin (1994) for more details.

interest on chartered bank balances, and interest on loans and advances made by the federal government. Interest receipts on bonds and treasury bills are calculated as the product of the effective interest rates and the stock of bonds and treasury bills held by the Bank of Canada. Other categories of revenues are set exogenously.

Direct taxes on non-residents represent withholding taxes paid by non-residents on investment income received from Canadian sources. These revenues are modelled on dividend and interest payments to non-residents.

Current transfers from persons represent only a small portion of federal government revenues. The transfers include items such as hospital and medical care premiums, the personal share of motor vehicle licences and permits, miscellaneous licences and permits, and various fines and penalties.

The capital consumption allowances for fixed capital formation are modelled under the assumption that they follow a declining balance profile based on replacement cost. The capital consumption allowances are treated both as revenue and as expenditure items, and hence have no impact on government balances.

### 8.2 Federal Expenditures

In general, federal government expenditures are set by legislation through budgetary processes. As a result there is much less interaction between expenditures and the real sector of CEFM96 than there is with federal revenues. For this reason, equation specifications in the expenditure block are much simpler than those in the revenue block, and several expenditure variables are set exogenously with no feedback allowed. Some of the expenditure variables--for example, interest payments on the public debt--are allowed to deviate from their predetermined values in simulations in response to changes in economic variables through a set of simulation rules. Also switch variables can be turned on in simulation modes to keep real government expenditures on goods and services and capital formation fixed at control levels.

Two broad groupings of federal government expenditures are current expenditures and gross capital formation. Current expenditures include expenditures on goods and services; transfers to persons; transfers to non-residents; subsidies; capital assistance; transfers to provinces, municipalities, and hospitals; and interest payments on the public debt. Gross capital formation includes fixed capital formation and changes in inventories. Expenditures on goods and services and gross capital formation enter directly in the calculation of GDP.

Expenditures on goods and services include spending on wages and salaries, non-wage goods and services, military pay, and capital consumption allowances for fixed capital formation. Except for the capital consumption allowances, all other expenditure items in this group are set exogenously with no feedback.

Total federal transfers to persons include old age security, unemployment insurance benefits, pensions to government employees, the child tax benefit, and other transfers. Old age security payments are modelled using statutory rates, institutional variables, demographic variables, and the inflation rate (for indexation purposes). Other types of transfer expenditures are set exogenously with no feedback.

Transfers to non-residents include expenditures such as foreign aid and are set exogenously with no feedback. Subsidies include payments to agriculture, communication, and energy, among others. All these items are set exogenously with no feedback. Capital assistance includes assistance to both business and persons. They are set exogenously with no feedback.

Transfers to PLH governments represent federal expenditures on the Canada Assistance Plan, on Established Programs Financing, and Fiscal Equalization, as well as other transfers. Expenditures on the Canada Assistance Plan, Fiscal Equalization, and other transfers are set exogenously, while various demographic and economic variables are used to model expenditures on Established Programs Financing. Beginning on April 1, 1996, Canada Assistance Plan and Established Programs Financing was replaced by the Canada Health and Social Transfer.

Interest payments on the public debt include interest on domestic marketable bonds, interest on publicly held funds, interest on foreign bonds, interest on other liabilities, interest on Canada Savings Bonds, and interest on treasury bills. The modelling of interest on the public debt is extremely difficult within the context of CEFM96 because of the problem of taking into account the past and expected future portfolio structure of the debt. For this reason interest payments on the public debt are calculated by a satellite model outside CEFM96, and government debt stocks do not enter directly into the model. Consequently, most interest payment variables in the expenditure block are set exogenously. A set of simulation rules does allow interest payments to respond to interest rate and debt changes during policy simulations.

Finally, gross capital formation is defined as the sum of fixed capital formation and changes in the value of federal inventories. Both fixed capital formation and changes in the value of federal inventories are set exogenously.

## 8.3 Provincial-Local-Hospital (PLH) Sector

### *8.3.1 Revenues*

The structure of the PLH levels of government is similar to that of the federal government. Revenues consist of current revenues, including direct tax on persons, direct tax on business, indirect taxes, transfers from persons, investment income and transfers from the federal government, and capital consumption allowances. In general, there is no separate treatment of individual provinces in the model, but Quebec is removed from the aggregate and considered distinctively for the determination of personal income tax and QPP collections.

Direct tax on persons includes personal income tax, payroll tax, estate tax, and employer/employee contributions to PLH public service pensions, workers compensation, and industrial vacation claims. Only the personal income tax and the payroll tax are determined endogenously. The other two types of direct taxes are set exogenously.

There are two components to the PLH personal income tax revenues: tax collections for Quebec and those for the other nine provinces. Quebec is considered separately because it has its own income tax system, while taxes for the other nine provinces are collected on their behalf by the federal government. Quebec personal income tax collections are modelled on the federal assessed income for all taxable filers, and personal income tax collections for the other provinces are modelled on the federal basic tax.

The PLH payroll tax variable refers only to payroll taxes collected in Ontario, Quebec, and the Northwest Territories. In Manitoba and Newfoundland, payroll taxes are considered as part of indirect taxes. The structure of the PLH corporate income tax is modelled on federal corporate taxable income.

Indirect taxes include of retail sales tax, motive fuel tax, real estate and personal property taxes, motor vehicle licence fees and permits, tax on profits of liquor commissions, and other indirect taxes. Retail sales tax, motive fuel tax, and real estate and personal property taxes are determined endogenously, while the other indirect taxes are set exogenously. As a proportion of total indirect tax collections, about 30 per cent are from retail sales tax, 39 per cent from real estate and personal property taxes, and 8 per cent from motive fuel tax.

In general, retail sates tax revenues are derived as follows:

$$PRST = \sum_i \tau_{PROV} \cdot TBASE_i \qquad (8.3.1.1)$$

where $PRST$ is total sales tax revenues, $\tau_{PROV}$ is a weighted-average of provincial sales tax rates, and $TBASE_i$ is the provincial sales tax base for final demand category $i$.

Since the tax base is not directly observable, it is calculated by:

$$TBASE_i = \frac{\rho_{i,PROV} FD_i}{1 + \rho_{i,PROV} \tau_{PROV}}$$

where $FD_i$ is the final demand for category $i$, and $\rho_{i,PROV}$ is the proportion of final demand category $i$ subject to provincial sales tax. As for the GST, these taxable proportions are calculated using input-output tables.

Other indirect taxes include motive fuel tax and personal property taxes. Motive fuel tax is determined endogenously, modelled on the portion of fuel consumption subject to provincial

motive fuel taxes and a weighted-average of provincial tax rates. Real estate and personal property taxes are modelled on nominal expenditures on residential construction.

Other PLH revenues include transfers from persons, investment income, transfers from the federal government, and capital consumption allowances. Transfers from persons are exogenous to the model. Investment income consists of interest receipts and royalties. Interest receipts are modelled on interest rates and asset stocks of the PLH governments. Oil and gas royalties are derived from an equation that includes as determinant oil and gas prices, corresponding volumes, and average royalty rates. The category of transfers from the federal government is the mirror image of the transfers to PLH discussed above. It is an expenditure item for the federal government but revenue for the PLH governments.

Finally, capital consumption allowances follow the same structure as the federal capital consumption allowances. The capital consumption allowances for fixed investment are modelled under the assumption that they follow a declining balance profile based on replacement cost. Similar to federal capital consumption allowances, they are recorded as both, revenue and expenditure items and thus they have no effect on the PLH balance.

*8.3.2 Expenditures*

The PLH government expenditures is the sum of spending on goods and services, transfers to persons, interest payments on the public debt, subsidies to business and persons, capital assistance, and gross capital formation.

Expenditures on goods and services include spending on wages and salaries, non-wage goods and services, and capital consumption allowances. Both spending on wages and salaries and non-wage goods and services are set exogenously.

Transfers to persons include direct relief payments, spending on post-secondary education, and other transfers. Payments on direct relief are modelled on the generosity of unemployment insurance benefits, unemployment rates, and the segment of the population that is not part of the labour force. Spending on post-secondary education is modelled on demographic variables, while spending on other transfers is assumed to grow at the same rate as the inflation rate.

The total interest payment on the PLH government debt is divided between payments to CPP fund and other payments. Following the standard accumulation rule, the current PLH government debt corresponds to the current government deficit plus the debt in the previous period. The component of this government debt that is held by the CPP fund is removed before an effective interest rate is applied to calculate interest payment net of payments directed to the CPP fund. Interest payments to the CPP fund, which are estimated in the CPP/QPP block, are then added, to estimate total interest payments on the PLH government debt.

The rate of change in other current expenditures--which are subsidies to business and persons, and capital assistance--is assumed to follow the inflation rate. The same assumption is used to model gross capital formation.

### 8.4 Canada and Quebec Pension Plans

The CPP/QPP block estimates contributions, benefits, and investment income for both the Canada Pension Plan and the Quebec Pension Plan.

Contributions to each of the plans are estimated as a function of the amount of contributions that would be made if all individuals in the labour force contributed to the relevant plan at the maximum amount, and a ratio that measures average pensionable earnings. The ratio is used to determine by how much the CPP and QPP contributions fall short of the maximum contribution amount.

To estimate the maximum contribution amount, the labour force inside and outside of Quebec is estimated using a ratio that is exogenous to CEFM96. The maximum individual contribution amount is equal to the estimated maximum pensionable earnings less the estimated basic exemption. The maximum pensionable earnings and the basic exemption are estimated using the indexing provisions of the *Canada Pension Plan Act* and its Quebec equivalent.

CPP and QPP benefits are estimated as the product of estimates of the average benefit amounts and the number of beneficiaries of the two plans. The estimated number of beneficiaries of the two plans is exogenous to CEFM96. The average levels of benefits offered by the plans, including retirement, disability, survivor, and death benefits, are estimated by applying ratios that are exogenous to CEFM96 to the estimated maximum pension benefit amounts. The maximum pension benefit amounts are estimated using the indexation provisions of the *Canada Pension Plan Act* and its Quebec equivalent.

CPP investment income is estimated by applying a weighted interest rate to the cumulative CPP account balance. The weights are determined by the average yield on the long-term Government of Canada bond rates and the account balances in each period to represent the amounts invested. QPP investment income is determined in a similar way with an exogenously determined return differential to account for the fact that the QPP invests part of its account balances in variable-return assets.

## 9 CONCLUDING REMARKS

In this paper, we document the structure of the 1996 version of the Canadian Economic and Fiscal Model, CEFM96, at a fairly detailed level. This version of the model differs from previous ones in many respects. First, the size of the core model has been greatly reduced. Second, key economic relationships have been reframed within error-correction models. Finally,

for these key relationships, we have applied at the estimation stage an econometric methodology inspired by recent developments in the macroeconometric analysis of time series.[59] These major changes have improved the underlying theoretical foundations of the model as well as its ability to forecast properly.

Although, in our view, CEFM96 is a better tool for forecasting and policy analysis than previous versions of the model, this does not mean that there is no room for further improvement. For example, a more formal link between flows and stocks of assets would be an interesting feature to develop. Among other things, this would allow us to more closely link the empirical and the theoretical specifications in the household sector.

[59] See Cao and Robidoux (1998) for more details.

TABLES

Table 1
A Selection Of Key Elasticities And Semi-Elasticities*

| **Household sector** | Income elasticity | | Long-term real int. rate semi-elasticity | | Interest rate spread semi-elasticity | |
|---|---|---|---|---|---|---|
| | SR | LR | SR | LR | SR | LR |
| Consumption | 0.20 | 1.22 | 0.00 | -0.74 | -0.43 | -2.06 |
| Housing investment | 0.00 | 1.67 | 0.00 | -1.54 | -1.09 | -2.04 |
| **Business investment** | Output elasticity | | Real user cost elasticity | | Output gap elasticity | |
| | SR | LR | SR | LR | SR | LR |
| Machinery and equipment | 0.37 | 1.00 | -0.12 | -1.00 | 0.27 | 3.25 |
| Non-residential construction | 0.58 | 1.00 | 0.00 | -1.00 | 0.35 | 6.80 |

| **Labour markets** | Output gap | |
|---|---|---|
| | SR | LR |
| Employment elasticity - exogenous labour force | 0.12 | 0.48 |
| endogenous labour force | 0.21 | 0.85 |
| Unemployment rate semi-elasticity – exogenous labour force | -0.12 | -0.43 |
| endogenous labour force | -0.16 | -0.54 |

| **Trade flows** | Activity elasticity | | Price elasticity | |
|---|---|---|---|---|
| | SR | LR | SR | LR |
| Exported commodities | 1.02 | 1.11 | -0.24 | -0.44 |
| Exported end products | 2.74 | 1.44 | -2.04 | -1.53 |
| Exported services | 2.16 | 1.47 | 0.00 | -0.38 |
| Aggregate exports** | 1.95 | 1.30 | -1.04 | -0.93 |
| Imported commodities | 1.92 | 1.40 | 0.00 | -0.30 |
| Imported end products | 2.06 | 1.06 | 0.00 | -0.73 |
| Imported services | 1.88 | 1.00 | -0.86 | -1.09 |
| Aggregate imports** | 1.99 | 1.13 | -0.16 | -0.69 |

| Production and cost functions parameters | | | | | | | |
|---|---|---|---|---|---|---|---|
| $\alpha\gamma$ | 0.64 | $\alpha'\gamma$ | 0.62 | $\gamma$ | 0.95 | $\kappa$ | 0.6 |

* SR and LR indicate short run and long-run elasticities respectively. The short run elasticities and semi-elasticities correspond to the impact after 1 or 2 quarters.
** Using 1990-1994 weights to aggregate

Table 2

Weights Used In The Construction Of Foreign Activity And Prices For Export Functions

$(\omega_j^i, \eta_j)$

| G-6 Countries (j) | Export categories (i) | | | | |
|---|---|---|---|---|---|
| | Total | | Commodities | End products | Services |
| | $\eta_j^*$ | $\omega_j^i$ | $\omega_j^i$ | $\omega_j^i$ | $\omega_j^i$ |
| United States | 0.331 | 0.857 | 0.804 | 0.961 | 0.749 |
| Japan | 0.303 | 0.065 | 0.108 | 0.006 | 0.074 |
| Germany | 0.411 | 0.018 | 0.022 | 0.009 | 0.034 |
| France | 0.497 | 0.012 | 0.014 | 0.006 | 0.034 |
| Italy | 0.497 | 0.013 | 0.012 | 0.003 | 0.034 |
| United Kingdom | 0.473 | 0.033 | 0.040 | 0.015 | 0.075 |

* 1989-92 average from International Trade Statistics Yearbook, Vol 1, United Nations 1992.

Table 3

Propensities To Imports ( $\varpi_f^i$ )

| Final demand categories (f) | Imports(I) | | | | |
|---|---|---|---|---|---|
| | Total | Goods | Commodities | End products | Services |
| $C_{NH}$ | 0.217 | 0.178 | 0.066 | 0.110 | 0.042 |
| $C_H$ | 0.036 | 0.017 | 0.008 | 0.009 | 0.040 |
| $I_H$ | 0.174 | 0.135 | 0.060 | 0.073 | 0.053 |
| $I_S$ | 0.179 | 0.146 | 0.067 | 0.077 | 0.037 |
| $I_M$ | 0.645 | 0.571 | 0.055 | 0.517 | 0.025 |
| $G_C$ | 0.217 | 0.168 | 0.048 | 0.119 | 0.068 |
| $G_I$ | 0.245 | 0.207 | 0.058 | 0.148 | 0.035 |
| $X_C$ | 0.153 | 0.128 | 0.092 | 0.032 | 0.023 |
| $X_F$ | 0.408 | 0.359 | 0.063 | 0.296 | 0.020 |
| $X_S$ | 0.090 | 0.060 | 0.030 | 0.030 | 0.052 |

Table 4

Correspondence Between Main Text Symbols And Program Code

| Symbol | Description | CEFM96 |
|---|---|---|
| A(a) | CS total factor productivity (trend) | TFPC(T) |
| C | Total consumption per capita | C86/LFPOP |
| CA | Current account | NXCA |
| $C_H$ | Paid and imputed rent consumption | CRENT86 |
| CT | TE marginal production cost | COST |
| E(e) | CS employment level (potential) | LF(N)EC |
| GW | Real government expenditures on wages | GW86 |
| H(h) | CS yearly hours worked per employee (trend) | LFAHC(N) |
| $I_H$ | Residential construction investment per capita | IRC86/LFPOP |
| $I_M$ | Machinery and equipment investment | IME86 |
| $I_S$ | Non-residential construction investment | INRC86 |
| $INV_B$ | Business inventory change | INVB86 |
| $INV_G$ | Government inventory change | INVG86 |
| $IP_M$ | Interest income and dividend payments to foreigners | MSIID |
| $IP_X$ | Interest income and dividend payments received from foreigners | XSIID |
| IT | Index of technological change in inventory management | COMPUTER |
| $K_{INVB}$ | Business inventory stock | KINVB |
| $K^D_{INVB}$ | Desired business inventory stock | KINVBD |
| $K_M$ | CS M&E net capital stock | KIME |
| $K_S$ | Cs non-residential construction net capital stock | KINRC |
| $KI_A$ | Foreign asset stock held by Canadians | KIA |
| $KI_L$ | Domestic asset stock held by foreigners | KIL |
| L(l) | CS labour force (trend) | LFC |
| $M_C$ | Imports of commodities | MC86 |
| $M_F$ | Imports of end products | MM86 |
| $M_S$ | Imports of services | MS86 |
| $M^N$ | Nominal total imports | M |
| NA | Net foreign assets | NETID |
| NUIM | Net immigrant funds | NXIMF |
| NXTR | Net current transfers from foreigners | NXRT |
| P | CS GDP deflator at factor cost | PGDPC |
| $P_R$ | Price of natural resources | PRAW |
| PT | TE market price GDP deflator | PGDP |
| $PT_{FC}$ | TE factor cost GDP deflator | PGDPFC |
| $PT^{US}$ | U.S. GDP price deflator | USPGDP |

[1] The acronyms CS and TE stand for commercial sector and total economy, respectively.

Table 4 (Continued....)
Correspondence Between Main Text Symbols And Program Code

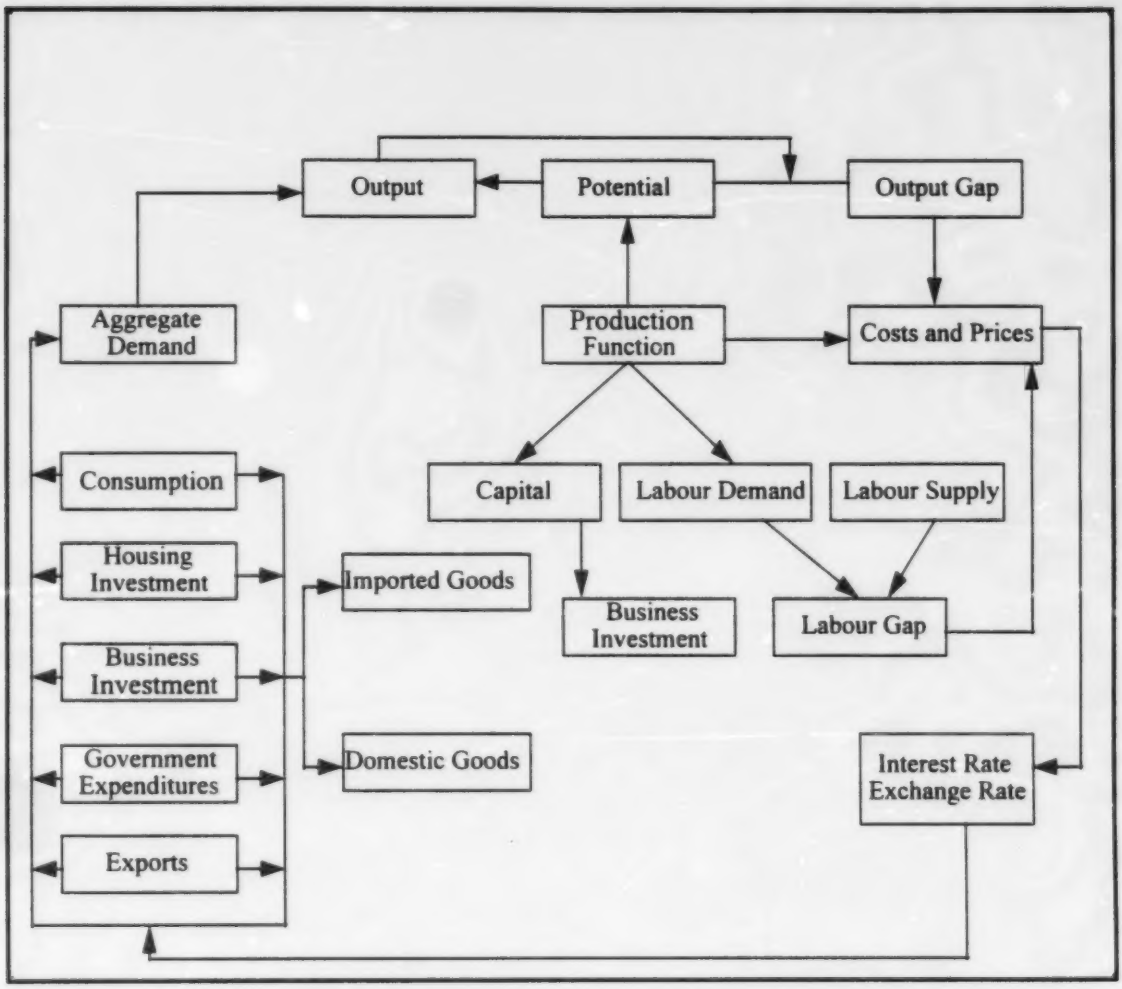
| Symbol | Description | CEFM96 |
|---|---|---|
| $P_C$ | Consumer price deflator | PC |
| $P_{CH}$ | Rent consumption price deflator | PCRENT |
| $P_{IH}$ | Residential investment price deflator | PIRC |
| $P_{im}$ | M&E investment price deflator | PIME |
| $P_{IS}$ | Non-residential construction investment price deflator | PINRC |
| $P_M$ | Price deflator for total imports | PM |
| $P_{MC}$ | Price deflator for imported commodities | PMC |
| $P_{MF}$ | Price deflator for imported end products | PMM |
| $P_{MS}$ | Price deflator for imported services | PMS |
| $P_{XC}$ | Price deflator for exported commodities | PXC |
| $P_{XF}$ | Price deflator for exported end products | PXM |
| $P_{XS}$ | Price deflator for exported services | PXS |
| PCPI | Consumer price index | PCPI |
| $R_{G13}$ | Average yield on 1-3 year government bonds | RGCB13 |
| $R_{LT}$ | Average return on 10-year over government bonds | RGCB10 |
| $R_M$ | Implicit rate of return on domestic assets held by foreigners | RMSIID |
| $R^{US}_{G3}$ | Average yield on 1-3 year us government bonds | USGB3 |
| $R^{US}_{G10}$ | Average yield on 10-year us government bonds | USGB10 |
| $R_X$ | Implicit rate of return on foreign assets held by Canadians | RXSIID |
| $R_{ST}$ | 90-day commercial paper rate | RFCP90 |
| $R^{US}_{ST}$ | U.S. 90-day commercial paper rate | USRFCP90 |
| S | Canada-U.S. exchange rate | PFX |
| SALES | Sales | S86 |
| $SUB^N$ | Nominal subsidies | GSUBF+GSUBP |
| $TI^N$ | Nominal indirect taxes | TINDF+TINDP |
| $UC_{INVB}$ | Business inventory user cost | UCINV |
| $UC_M$ | M&E user cost | UCME |
| $UC_S$ | Non-residential construction user cost | UCNRC |
| UIG | Employment/unemployment insurance generosity index | LUIGEN |
| UR(ur) | Unemployment rate (natural) | LF(N)UR |
| $W^m$ | CS market wage rate | WRC |
| WGAPL | CS reduced-form wage gap | LWGAP |
| WT | Wage rate - total economy | W |
| $X_C$ | Exports of commodities | XC86 |
| $X_F$ | Exports of end products | XM86 |

Table 4 (Continued....)
Correspondence Between Main Text Symbols And Program Code

| Symbol | Description | CEFM96 |
|---|---|---|
| $X_S$ | Exports of services | XS86 |
| $X^N$ | Nominal total exports | X |
| Y(y) | (Potential) GDP at factor cost – commercial sector | YGDPC(P)86 |
| $Y^N$ | Nominal GDP at market prices | YGDP |
| $Y^N_{CCA}$ | Nominal capital consumption allowances | YPCCA |
| $Y^N_{GNP}$ | Nominal gross national product | YGP |
| $Y_{GNP}$ | Real Gross national Product | YGNP86 |
| $Y^N_{ND}$ | Nominal net domestic income at factor cost | YNDI |
| $Y^N_{PROFIT}$ | Corporate profit before taxes | YBPROFDB |
| $Y^N_{WAGE}$ | Labour income | YPWSSL+YPMP |
| YN | Normal GDP at factor cost - commercial sector | YGDPCN86 |
| $Y^C$ | Adjusted disposable income per capita | YPERM |
| YT | Real GDP at market prices | YGDP86 |
| $YT_{FC}$ | Real GDP at factor cost | YGDPFC86 |
| $Z_M$ | Present value of capital cost allowances - M&E | PVCCAME |
| $Z_S$ | Present value of capital cost allowances - NRC | PCCCANr |
| $\delta_H$ | Housing depreciation rate | RDIRC |
| $\delta_M$ | M&E depreciation rate | RDME |
| $\delta_S$ | Non- residential construction depreciation rate | RDNRC |
| $\phi_M$ | M&E investment tax credit | RITCME |
| $\phi_S$ | NRC investment tax credit | RITCNR |
| $\sigma_j$ | Indirect tax rates | TAXR(j) |
| $\tau^I_j$ | Subsidy rates | SUBR(j) |

## Chart 1

## A Schematic Description of the Structure of CEFM96



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